FOR TECHNICAL PUBLICATLONS

Haagna
〈Siemens〉

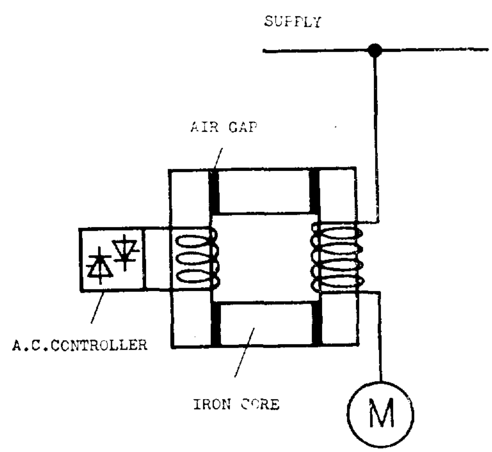
技術資料

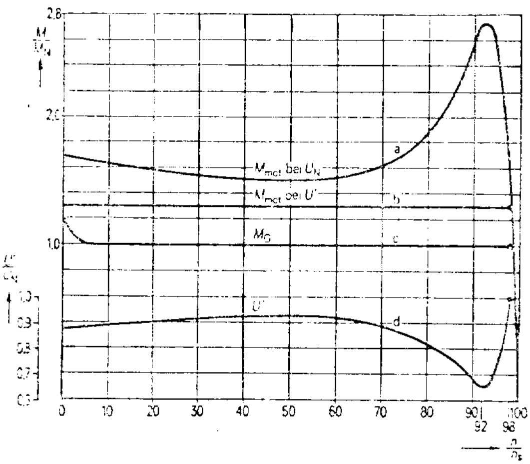
Smooth starting of a.c. squirrel-cage induction motors by means of the thyristor-controlled starting reactor

Since the a.c. squirrel-cage induction motor is robust, requires practically no maintenance and is very efficient, it makes an ideal drive. However, as more exacting demands are made on the driven machine, starting conditions are also being specified which the cage-type induction motor cannot fulfil by itself because of its starting characteristic. Siemens has developed a starting reactor controlled by thyristors which permits controlled starting of cage motors. Using this method, an induction motor drive with constant starting torque suitable for conveyor belts has been successfully tested.

For conveyor belts, it is desirable to have a starting torque that can be kept constant to a preset value throughout the starting period. The torque variation of a cage motor is very large and has a high maximum value (breakdown torque). The torque is proportional to the square of the voltage so that even small voltage variations are sufficient to result in large torque variations or, as the case may be, constant torque.

The starting reactor developed for this purpose by Siemens has an iron core laminated from normal electrical sheet steel with an air gap in the magnetic circuit. The motor is connected to the supply through the primary winding of the starting reactor, the secondary winding being short-circuited by an a.c. thyristor controller. The voltage at the motor terminals can be controlled by varying the firing angle of the thyristors so that the torque developed in the motor remains contant. Factors determining the dimensioning of the reactor are the magnitude of the motor breakdown torque, the current associated with this and the desired minimum stating torque. The starting reactor can be used with the simple and robust cage motor in place of the slipring motor which is more expensive and requires more maintenance or, alternatively, it can save the expense of a hydraulic clutch. This starting method permits any desired starting torque characteristic to be obtained. The starting equipment may also be used with h.v. motors. The reactor can also be used to limit the starting current. The output of the reactor is a constant

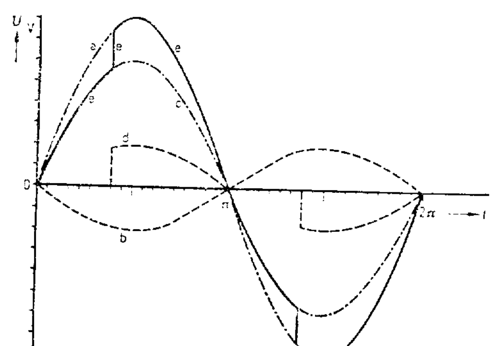




a) Characteristic of the motor starting torque at rated voltage
b) Desired constant motor starting torque
c) Load torque of the driven machine (conveyor belt)
d) Necessary voltage characteristic to obtain a constant torque

M	Torque	M_N	Rated torque
M_{mot}	Motor starting torque	M_G	Load torque
n	Speed	n_S	Synchronous speed
U'	Reduced voltage	U_N	Rated voltage

Fig. 1. Reducing the torque characteristic of a cage motor to a constant torque value by means of a controlled voltage



a) Voltage waveform with secondary winding short-circuited (excluding voltage drop across the reactor)
b) Counter emf induced in the primary winding-dependent on air gap in the reactor core
c) Resultant waveform form a) and b), i.e. the smallest possible voltage
d) Voltage induced in the primary winding from the secondary winding as a function of the firing angle of the thyristor
e) Desired voltage waveform to achieve a constant motor torque

Fig. 2. Controlled starting reactor

voltage the level of which can be controlled. The unit can be built for the highest output levels at relatively low cost and can be used in various ways where a controlled voltage is required or for loads sensitive to voltage variations.

A Century of the "Hall Effect"

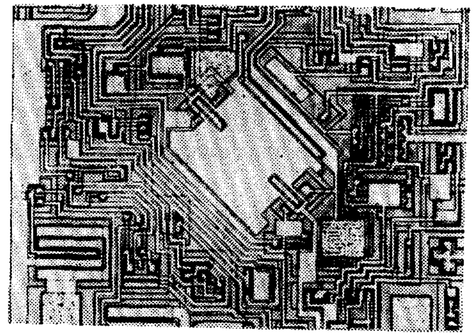
Under the heading "On a New Action of the Magnet on Electric Current", the November 1879 issue of the American Journal of Mathematics reported a new discovery. A few days before, using glass thinly coated with gold, E.H. Hall of the John Hopkins University in Baltimore had demonstrated for the first time that magnetic fields altered the distribution of elcetric current. However, the voltages produecd were far too low to be of any practical value, and it was not until the 1950s that Ⅲ～Ⅴ semiconducting compounds provided suitable material. Since then the Hall Effect, so named after its discoverer, has been used in Hall generators and magnetoresistors for a wide range of applications extending from instrumentation and control technology to automobile ignition. The products are available no the market as discrete semiconductors and as integrated circuits.

Among the Ⅲ～Ⅴ semiconductors examined at Siemens by H. Welker and his fellow-researchers, indium antimonide (InSb) and indium arsenide (InAs) were found to exhibit a high degree of electron mobility. The Hall voltage occurring between the edges of the flat semiconductor is several magnitudes higher than with metals and attains some 100 mV, which can easily be evaluated using modern electronics.

Hall generators with crystalline or vapour-deposited Hall chips are available in numerous variations with Hall voltages of up to 1000 mV. Generally speaking, both constant and alternating field can be evaluted. There are special designs for small air gaps, for measurement in point configuration, for tangential and axial fields and for extremely low temperatures down to −269°C. In addition, ferrite Hall generators can act as contactless signalling devices or can signal magnetic positions, while Hall multipliers are used for "electric multiplication", for power and torque measurement, and also for direct harmonic analysis of alternating magnetic fields.

The Hall effect is closely related to the variation of resistance in a magnetic field because, in the presence of a magnetic field, magnetoresistors utilize the extended path, caused by the NiSb needles incorporated in the semiconductor crystal, along which the electrons have to travel. If a magnetic field is applied to these devices the current changes its direction by the so-called Hall angle. An angle of about 80° can be obtained with an induction of 1 tesla. Thanks to this characteristic, magnetoresistors can be put to many uses as contactless and continuously variable resistors, e.g. in absolute encoders or in potentiometers. Magnetoresistor differential sensors can sense the rotational direction or the rotational speed of geared wheels and can be used for speed measurement in eddy-current tachometers.

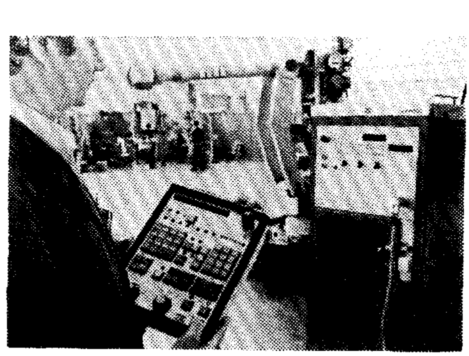
E.H. Hall's century-old discovery is meanwhile also being used in integrated circuits. The actual Hall probe (made of silicon) is located on the chip in the middle of the amplifier circuit. Siemens is manufacturing a whole range of these magnetically actuated contactless switches with analog or digital output. The maximum output voltage of analog circuits is 13V (SAS 231W). Hall integrated circuits such as these can be employed in situations where mechanical values need to be converted to electrical values using magnetic circuits. They have already proved their potential a million times over in revolution counters, accelerometers, hodometers, limit switches, pedals and pressure transducers. Keypads have, above all, become the domain of digital Hall integrated circuits.



Integrated amplifier circuit using the Hall effect: Set among the transistors, capacitors and resistors is the central Hall probe whose surface is sensitive to magnetic fields. Our picture shows the 1. mm × 1. 6mm chip of a digital Hall integrated circuit (SAS 251) which, operating as a magnetically actuated contactless switch, has proved its potential a million times over in keypads and similar applications.

Robot control for industrial handling

Variously utilizable industrial handling appliances operate more economically when their controls can also be flexibly adapted to the machine and its tasks. Siemens has therefore developed from its Sinumerik System 7 a point-to-point control for handling appliances with up to 5 axes which can be adapted to many problems by freely programmable inputs and outputs as well as specific interfaces for controlling gripping devices and tongs.



Siemens Robot Control, used here for spot welding-in an industrial robot of type 601/60 made by the Kuka Co.

The control is conceived to enable utilization with a maximum of availability. This is ensured by built-in monitoring routines, by a diagnosis module for service, and an interface which facilitates the rapid exchange of the entire control system for robots at critical points in the production process.

Great value has also been placed on ease of operation and a simple programming system. All conditions required for utilization as a continuos path control system have been taken into account.

In the automobile industry, this control is already variously in use in conjunction with the robot Famulus of Messrs. Kuka.