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DESCRIPTION OF

SIEMENS BROTHERS’ HIGH SPEED MOTOR UNISELECTOR

PHOTOGRAPHS REFERRED TO:- 8826 – 8832
DRAWING REFERRED TO:- V.552

SIEMENS BROTHERS & CO., LIMITED,

TELEPHONE DEPARTMENT,

WOOLWICH, LONDON, S.E. 18.

DESCRIPTION OF
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INDEX

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INTRODUCTION

(1) In acquiring automatic telephone equipment, administrations must necessarily consider the performance expected of the actual switching apparatus. The main questions are

(a) Will it establish connections speedily and reliably and without interference of any sort to other connections?

(b) Will it allow expensive plant with which it will be associated, to be used to the fullest advantage?

(c) What will be the cost of maintaining it?

(d) Has it a long economic life?

(e) To what extent will part replacements become necessary?

An affirmative answer to (a) is imperative. Regarding

(b), this can be ascertained only after the system using the switching apparatus has been considered as a whole but, broadly stated, we believe the key to this point is the use of switches capable of high selecting speed and flexible outlet-grouping. The answers to the remaining items depend mainly upon the mechanical principles used together with the way they have been put into practice. We have long had the conviction that a switch could be evolved which satisfies these points more fully than do present conventional designs and it is this which has led to the development of the Motor Uniselector. We make one broad claim for it, that it sets a standard of performance unequalled by any other type of automatic telephone switch,

(2) The switch is similar to other designs of uniselectors in that wipers traverse arcs of contact segments. Beyond this, however, the similarity ceases, the design representing a radical departure from conventional practice. Of its novel features the most noteworthy is the speed at which search takes place. This is done at the rate of 210-220 steps

per second, which means that no less than 50 outlets can be covered in the dial inter-digital pause. Stated another way, it means that the maximum permissible group availability becomes at least two and a half times that of the British Post Office standard selector, using at the same time the simpler scheme of testing the outlets one at a time. In this connection, the testing principle used is that of straightforwardly searching for the presence of a battery potential, the advantages of which need no stressing.

(3) The feature of next importance is that a constant– velocity drive is used. The wipers are propelled through gearing by a self–contained electric motor. This use of a non-reciprocating driving system greatly reduces noise and wear and tests have indicated that the life of the switch should be much greater than that of any ratchet-driven type. Further, the smoother drive results in a remarkable freedom from parasitic noises such as usually arise from microphonic action at wipers, banks and feeders.

(4) The attached photographs show the switch complete and in several stages of dissembly. They are -

8826 Switch Left side view.

8827 Switch Front view.

8328 Switch Right side view.

8829 Bank only.

8830 Mechanism only.

8831 Mechanism partly dissembled.

8832 Mechanism still further dissembled

(5) The switch is designed. so that the mechanism can be easily inserted or withdrawn from the bank, This dissociation allows a full complement of banks and multiple to be installed without the necessity for fitting all of the banks with mechanisms. The connections to the mechanism are

made by form wiring directly soldered to the components, a matter of never more than eight points. Jacking knives have not been adopted. Our experience is that they are potential sources of trouble and we have taken the line of foregoing what little traffic advantage they might offer in order to have a switch of the highest possible electrical efficiency. In any case it is claimed that even were a perfect jacking device available, its incorporation for maintenance purposes would be unwarranted owing to the extremely small fault liability of the switch.

BANK

(6) There are two sizes of bank, 8-arc and 16-arc. The photographs show the latter size. Each arc (or level) consists of 52 contacts and one feeder, making a total of 832 contacts and 16 feeders for the whole bank. Photograph *No.8829* also shows an extra arc of 26 wiring tags. These do not project into the contact field. They are fitted to facilitate flexible group-marking, such as provided for on our No.17 System group selectors. The permanent rack wiring goes onto these tags and the connections are then extended by cross-connecting wires to the relevant contact tags.

(7) The top right bank lug carries a detail also with some segments in it, (bank extension unit). It is fitted on No.17 System final selectors, when required, in connection with a comprehensive scheme evolved for filtering busy subscriber calls.

(8) All contacting segments are brass, levels being separated by aluminium sectors flanked with sheet bakelite. The bank is held together under heavy compression by high-tensile steel screws and nuts All metal spacers are bonded so that everything except the contacts and feeders can be earthed. The ratio of segment width to space is such that

overbridging of talking circuits cannot occur and the comparative narrowness of the segments helps to reduce wear at the wiper tips. The feeder springs are phosphor bronze and they give four contacting points per wiper.

(9) The soldering ends of the contacts project about an inch rearwards, allowing the use of a novel form of flat multiple cable. This cable fits into the gaps between rows of contacts and consists of the usual type of insulated multiple wire laid up between a folded adhesive tape; suitable transpositions are introduced as an anti-crosstalk measure. A one-pitch piece of cable is shown in Photograph No.8829. Bared loops project from one edge of the cable and are hooked into diagonal slots near the extremities of the bank tags. The mechanical details of this cabling scheme have been influenced largely by the question of soldering. The construction adopted allow the use of a soldering process giving extremely low fault liability and at the same time producing joints of uniform strength and appearance.

An inset-ribbon multiple has advantages over the usual method in several directions and some of them are as fol1ows—

(a) Multiple has a neater and more compact appearance

(b) There is less liability of burning it when soldering.

(c) All joints are open for inspection.

(d) anti-microphonic mountings are not necessary because the switch vibration is so small a rigid multiple without inter-bank slack can therefore be used. This principle of storing the cable solidly in the bank considerably reduces the liability of wire breakage and solder crystallisation.

(e) Multiple resistance is minimised by the running of wires from bank to bank by the shortest possible route.

(f) The imprisonment of the wire within moisture— resisting tape results in a multiple of low leakance.

(g) The compactness of the multiple allows more room for running local forms and as a result, allows a better overall rack wiring arrangement. Vertical form butts can be distributed over the full rack width, one good effect of which is to keep the rack form resistance low.

(10) Banks are mounted with their arcs vertical, thus resulting in horizontal multiplies. This arrangement is an extremely important feature from the maintenance viewpoint as vertical contacting surfaces do not readily collect dust. Horizontal surfaces provide dust-collecting shelves and can give rise to a lot of trouble, especially when the contacts are lubricated. The banks are fitted to their panel frameworks by screws which pass through clearance holes in the framework bars and then into threaded details in the bank fixing lugs. The tag screwed to the face of the lower left lug is provided so that a reliable bonding connection (to earth) can be made.

(11) The right side of the bank carries a steel plate into which the mechanism sideplate fits and locks. The construction will best be seen in Photographs Nos.8829 and 8830. The mechanism plate has at its top right corner a lug which registers with the horizontal slot in the bank plate. The mechanism is fitted into the bank by first pushing it forward a far as it will go and then swinging it downwards. The lug thus turns into the locking recess in the bank plate, rotation being about the shouldered nut in line with the wiper spind1e. At the same time, the locking bolt lower down the mechanism plate will have entered the radial slot in the bank plate. The mechanism is set to a position in which the wipers lie in their correct setting on a row of contacts, after which the adjustment is rigidly held by tightening the bolt. The most important feature of this design is that although the mechanism can be inserted easily and simply, once the bolt is tightened there is no possibility of anything shifting.

MECHANISM: GENERAL

(12) The mechanism can be divided into three main parts, viz.,

(a) Wiper assembly.

(b) Motor, for rotating the wipers.

(c) Latch system, for stopping drive and locking the wipers into a selected position.

The motor system can be identified by the two magnets set at 90 degrees displacement whilst the latch system is the single magnet and associated mechanism above it.

WIPERS

(13) The wiper system embodies several important features. In the first place, they are exceedingly robust and will stand a considerable amount of rough handling without adjustments being impaired. Secondly, the assembly incorporates a scheme for neutralising clamping rod torsion stresses; this ensures that under extreme temperature variation and ageing conditions and after prolonged use, it is practically impossible for the wipers to become out of alignment. Thirdly, they have been shaped so that there is no tendency for the tips to flex out of their proper relationship with the bank segments. This is accomplished chiefly by providing stiffening ribs and arranging that the contact tips project as little as possible away from the main stem of the wiper. A fourth feature is that single-ended wipers are fitted with tails, thus allowing their feeders to be swept automatically into position when inserting the mechanism into the bank. A fifth feature is the particular ease with which tracking and tension adjustments can be made. No finicky operations are entailed, tensioning being done merely by bending the wipers at their base.

(14) The assembly includes a number ring at one end and a 104-tooth wheel at the other. The bearings are two brass collars which rotate on a steel spindle attached to the mechanism sideplate. The spindle is stepped to avoid damaging the wheel-end bearing when passing it over the free end of the spindle. This free end is held firmly by the bank V-bracket, a detail capable of lateral movement and

tensioned so that it presses onto the spindle; the scheme provides a bearing which, whilst securely positioning the spindle, leaves the left side of the bank open for inspection.

(15) The number ring is detachable, which means that rings can be changed, perhaps to suit particular circuit arrangements, without having to loosen the wiper assembly.

(16) There are many ways in which wipers can be arranged, the photographs show a representative one, being the layout for 200-outlet selectors in the No.17 System. There are four sets each of four wipers, two sets projecting one way and two oppositely. Of each set, three of the wipers are grouped to form a “P, +and – set”, whilst the fourth, G, is located at the wheel end of the assembly, This last wiper (and its associated bank level) is used for marking groups of outlets associated with particular dial numerals and is separated from the other wipers in order to make the multiple arrangement as simple as possible. P and G wipers having bridging tips whilst the others have line-contact tips. It should be noted that all wipers make contact on both sides of their bank segments, a scheme which is conducive to high- efficiency electrical connections,

GEAR SYSTEM

(17) The wiper system is coupled to the motor by a speed-reducing idler gear consisting of two concentrically-coupled wheels with a tooth ratio of 5 : *2.* The complete gear train is as follows :-

Motor pinion, 10 teeth - Idler wheel, 35 teeth

Idler wheel, 14 teeth - Wiper wheel, 104 teeth

This means that the motor does a quarter of a revolution for each wiper step. (In the subsequent description, bracketted numbers in the text refer to the details shown in Photograph No.8832),

(18) The motor pinion and wiper wheel axes have fixed positions on the mechanism sideplate (2). The idler gear (15), however, is adjustable and it is arranged that after obtaining the correct motor pinion mesh it is not upset when subsequently fixing the mesh of the wiper wheel The stub of the idler gear axle (14) fits into the left hole of detail (13), the right hole of which encircles the motor axis (8). The idler axis is eccentric to its stub so that rotation of the stub by the projecting fang in (14) controls the motor pinion mesh. The wiper wheel mesh is then set by swinging the whole idler sub-assembly about the rotor skis. A clamping screw engaging the radial slot in detail (13) holds this latter adjustment. The axle is lubricated in the same way as described later for the motor axle.

MOTOR

19) The motor system consists of a pair of electro—magnets (12), a return pole (6), a rotor (7) and an interrupter (4). The basic rotor component is a steel tube which slides over a bronze bearing spindle. The latter is fastened to the sideplate by a brass nut, the face of which acts as a thrust bearing. The other rotor parts are a pinion, an armature and a cam. These can clearly be seen in Photograph No.8831, which shows the rotor withdrawn from its spindle. The armature consists of a pair of soft iron details clamped to form two sets of main and auxiliary poles. The cam is red fibre and it engages two movable steel springs which project from the interrupter assembly.

(20) The rotor bearing spindle (8) is hollow and contains an oil—saturated wick. Oil is introduced to a hole in the spindle base (appearing on the right side of the plate) and is fed to the bearing faces via transverse holes. A free circulation of oil is assisted by a breather hole at the cam end of the rotor tube.

(21) The motor operates by the automatic and alternate energisation of its two magnets. Each of these (9) is attached to a yoke (11). Interposed is a detail (10) which makes the curved poleface of the magnet take up its proper setting. Wired in series with each magnet is a pair of interrupter contacts and the cam in rotating opens first one pair and then the other. The rotor has no winding nor is any electrical connection made to it.

(22) The interrupter system has several novel features. Firstly, if the two long-headed screws holding the stirrup (3) to the mounting pillars are loosened, the whole assembly can be slipped out of position. This leaves the rotor free to be pulled off its spindle. Secondly, the point of most finesse in the switch is the relationship of the two moving springs to each other. This is a matter, however, which will never trouble an administration, the springs have their "tails" coupled to form one blank so that provided the factory punching tools are correct, the tip relationship will always be right. Thirdly, tension adjustments are done by means of vernier-thread screws. The tips of these screws engage steel buffer springs which in turn apply pressure to the moving springs directly behind their tungsten contact points. The buffers act not only as a tension-reduction gear but they are also instrumental in practically eliminating contact vibration. Photograph No. 8832 shows a detail (5) which slides over the interrupter pillars. This presents a white background to the contacts and thus facilitates adjustments in poorly-lighted positions.

(23) The action of the motor and the manner in which a continuous torque is produced is best explained by reference to Figs.2-5 in diagram V.552. Commence with Fig.2. At this stage the interrupter will have magnet 1 in circuit and torque on main pole 3 will produce clockwise rotation.

When pole 3 reaches the position in Fig.3 the interrupter contacts change over and magnet 2 generates the field, At this stage, auxiliary pole 4 presents its face to magnet 2 and a strong clockwise torque is maintained. Rotation continues and in Fig.4 the on pole 4 has changed from torque to axial pull. The latter is small, however, as pole 4 has presented its edge of restricted area to the magnet and this, combined with the relatively large air gap, results in the majority of the flux passing to main pole 3. A strong clockwise torque is, thus still maintained. Fig.5 shows the stage at which magnet 1 again comes into action, this time on poles 6 and 5.

(24) To ensure that the motor will start irrespective of it rotor and interrupter position, it is necessary that the interrupter contacts shall be make-before-break in action, otherwise there would be **a** critical position in which both magnets could be open-circuit. This necessary degree of simultaneous closure is an adjustment that will never concern an administration as it is fixed, once and for all, in the factory.

(25) Provision is made for a certain degree of speed adjustment. This is done by altering the phase relationship between the interrupter and the magnet system. By loosening two screws which thread into the stirrup (3), the whole assembly (4) can be swung through an arc of about 10 degrees, the two fingers on the stirrup determine the limits of phase shift. Speed is reduced by swinging the interrupter clockwise (i.e. “retarding” it) advancing it by swinging it in an anti-clockwise direction increases the speed.

(26) Speed change actually is brought about by flux decay effects. If the interrupter is retarded, the rotor main pole will progress beyond the magnet dead-alignment position

before the flux has fully collapsed. A braking effect is thus produced. If the interrupter is advanced, the braking effect is lessened, merely because more time is allowed for flux to decay prior to the rotor aligning with the magnet.

LATCH SYSTEM

(27) The wipers are brought to rest on a set of contacts by means of the latch system, most clearly illustrated in Photograph No.8826. The principle used is a simple one. When an outlet is to be seized, a magnet is de-energised, an extension of its armature opens the motor circuit and then grips the wiper wheel. Whilst this might at first appear to be a drastic way of stopping wiper movement, it actually is not so. The momentum of a system depends upon its mass and upon the speed at which this mass is moving in this switch the mass, particularly at the larger radii, is low whilst the largest item, the wiper assembly, rotates at the comparatively low speed of about 120 revolutions per minute. There is still, of course, a fair amount of kinetic energy to be dissipated but certain devices are fitted for effectively absorbing it.

(28) The latch system consists of a sideplate (17) carrying a magnet and its yoke (21). The armature (18) pivots on a phosphor bronze axle (20) clamped by a steel saddle (19) to the yoke. The actual latching detail is bronze and it is normally pressed into the wiper wheel by a flat steel spring riveted to a lug on the latch sideplate. The detail is coupled to the armature by a pair of steel arms so dimensioned and shaped that flexibility is introduced in a direction in prolongation with the arms but is prevented in the direction described by the arc of armature movement. This means that whilst the angle of latch movement is always kept the same as that of the armature, a longitudinal give is introduced to absorb the momentum at the instant of stopping. Tendency

for the detail to bounce on the wheel rim is overcome by the damping effect of the latch restore spring. The pressure of this spring is adjusted by a screw and nut passing through the latch contact assembly, which components also help to hold the contact assembly together.

(9) Towards the end of the lifting stroke, the latch detail engages a contacting spring. This action completes the motor circuit and at the same time imposes extra restoring tension. A buffer arm supports the spring at its extremity and as the arm is long and very accessible, adjustments are easy to carry out. It is arranged that the contacts open on release only after the latch teeth drop below the wiper wheel crest circle. If, therefore, the teeth become placed into crest-to-crest contact for any reason, the mechanical closure of the latch contacts keeps power on the motor and thus causes the wipers to be driven into their proper positions

(30) The latch axle and detail describe a tangent to the wiper wheel pitch circle, which setting is automatically fixed by reason of the axle projecting into a hole in the mechanism sideplate. This tangential setting, coupled with a snugly-fitting latch detail, causes the wipers to be locked rigidly on to a set of bank contacts when the switch is at rest.

CIRCUIT ACTION

(31) The following is a summary of the actions occurring in driving to a free outlet. Refer to diagram V.552, Fig.1.

(a) Start contact is closed, this will be a contact of some relay associated with the switch.

(b) Latch magnet is energised.

(c) The latch detail is withdrawn from the wiper wheel and the contact closed.

(d) Motor functions and wipers rotate.

(a) Free outlet is reached and the test relay operates.

(f) Break contact of relay opens the latch magnet circuit.

(g) Latch contact opens, disconnecting energy from the mat or.

(h) Latch detail registers with the gear teeth, bringing the wipers to rest.

(32) The latch armature release lag is a little over two milliseconds. The break contact opening lag of the test relay is approximately half a millisecond. The latch magnet resistance is 100 ohms whilst that of each motor magnet is 48 ohms, The motor magnets are connected so that their fluxes flow in opposite directions. The motor attains full speed within two rotor revolutions, after which its mean running current is approximately one quarter of an ampere.

H0MING SPRINGSET

(33) In switches that return to a home position after use, like the one depicted in the photographs, drive to normal is arrested in another way. Instead of a test relay operating, a pair of mechanically-controlled contacts break the latch magnet circuit. The springs are of special design to ensure that the contacts always open at the right time, irrespective of any variations in contact opening and follow that might arise. The homing springset (22) is actuated by a red fibre cam fixed to the large gear wheel. In the photographs it will be seen that the springset has four springs. The lower two are those concerned with the stopping action the upper pair is provided for general circuit purposes and their contacts are closed only when the switch is at normal. All four springs are phosphor-bronze and they are fitted with twin silver contacts.

(34) To cater for special circuit cases, provision is made for fitting two, three or four homing cams in the 90 degree positions. Precise quadrantal displacement is assured by the cam fixing screws fitting snugly into slots in the wiper wheel and by the cam bases seating in slots in the gear wheel bearing collar.

GENERAL

(35) Beneath the forward latch magnet tag is a spring which, when pressed upwards, earths the magnet and so causes the switch to run. This provides a ready means for checking the driving action.

(36) Each switch is provided with a battery-cut-off jack located between the motor magnets. This jack consists of a pair of silver-contacted springs which are normally closed. When an insulating detail is inserted between their V—shaped ends, the contacts are parted and the battery supply for all magnets disconnected. The same jack is used for latch magnet tension calibration. The jack is also designed to take a small 50V. switchboard lamp, glass end first if the latch armature is manually operated, the lamp gives sufficient light around the interrupter system for all general inspection purposes. (The lamp laterally bridging the latch contact spring and its steel clamping plate also gives enough light to illuminate the number ring, a useful point when tracing calls).

(37) Except for the two vernier-thread screws in the interrupter system, all screws are British Association thread and over 8O of these are 4BA or larger.

(38) The finish of the main ferrous parts is zinc covered with zapon. All screws, steel or otherwise, are nickel finish to ensure easy threading. All steel springs are made from rust-proof material.

(39) The switch mounts on the standard horizontal channel centres, 4.75 inches. Its overall height and depth is 84 and 8.1 inches respectively. It weight is just over five pounds.

PERFORMANCE

(40) The uniselector is so radically different in its speed performance and its driving and stopping action, as compared with other types of switches, that many people initially are doubtful about its reliability and durability. Queries concerning reliability usually centre about the stopping action. Actually, there is an ample margin of safety for instance, if the motor be given a higher voltage merely to make it run faster, drive can be stopped satisfactorily, with standard adjustments, at speeds round about 300 steps per second. If special adjustments are imposed, still higher stopping speeds can be obtained. The motor cannot, of course, run anywhere near these high speeds when fed from the normal 50 volt battery.

(41) Regarding durability, there is first of all the well-known question of contact wear and distortion. In this connection, the motor interrupter contacts show no noticeable wear or distortion up to at least three million complete wiper revolutions. This has been achieved by a combination of springset design and special arrangement of contact material. The foregoing figure gives, by no means, an indication of the life of these contacts: the best way of putting it is that the switch will become obsolete before they wear out. The same remark applies to the latch contact. Regarding the wipers, provided the recommended maintenance procedure is followed, they should have an economic life of approximately two million complete revolutions. Incidentally, the wiper assembly can be removed from the mechanism (within about half a minute) without removing or disturbing the adjustment of any other mechanism component and it can be replaced with equal ease and speed.

(42) The most-queried point of durabi1ity is the life of the latch detail, Tests have shown that its wear is inappreciable even after ten million stoppings. In other words, a properly- adjusted detail should outlast the economic life of the switch. The wear on the wiper wheel teeth is even less than that on the latch detail.

COMMENTS ON THE HIGH SPEED RELAY

(43) Whilst the drive-stopping relay forms the subject of a separate report, it is proper to make some mention of it here as the motor uniselector depends so much for its success on the performance of the relay. Although the latch magnet is highly inductive and takes 0.5 ampere, the relay contacts undergo practically no wear, even after millions of operations. The contacts are sparkless, which is accounted for by the extremely high velocity at which they part, together with the use of an efficient spark quench. This quench, and those for the switch motor magnets, is of the condenser/resistance type and in this connection we have designed a triple condenser unit (with self-contained resistances) which fits into a standard relay space.

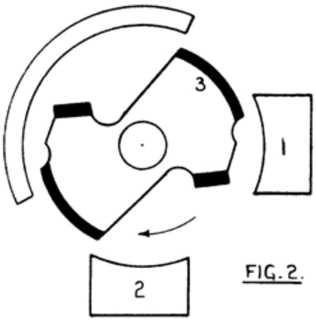

FIG. 2.

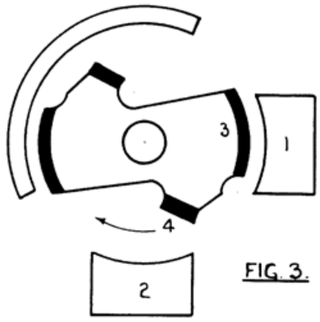

FIG. 3.

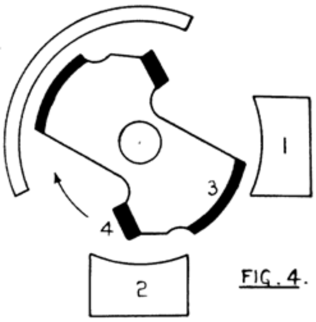

FIG. 4.

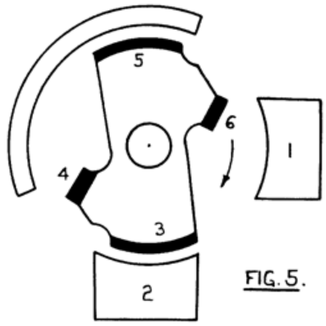

FIG. 5.

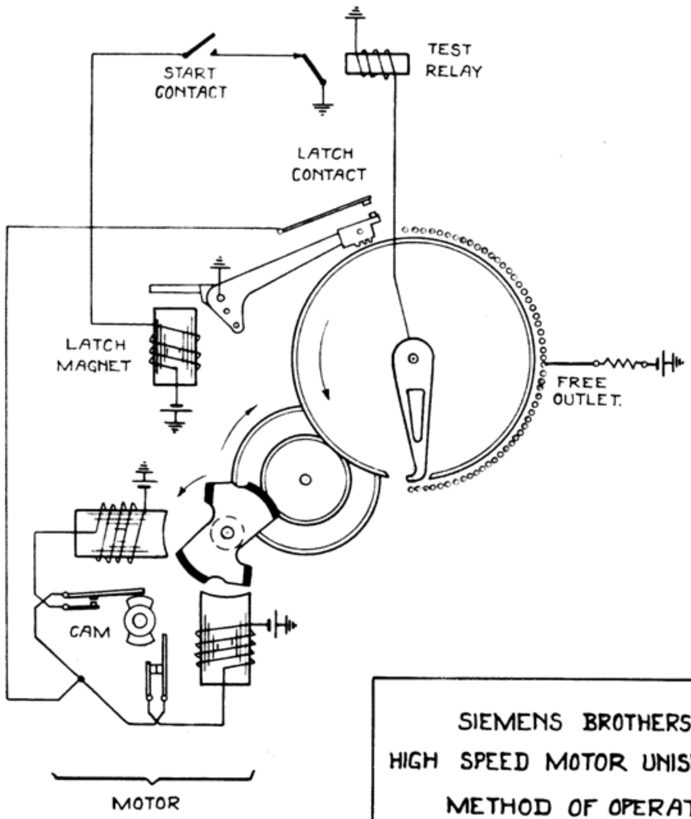

FIG. 1.

SIEMENS BROTHERS

HIGH SPEED MOTOR UNISELECTOR

METHOD OF OPERATION

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SIEMENS BROTHERS & Co Ltd WOOLWICH.

V. 552.

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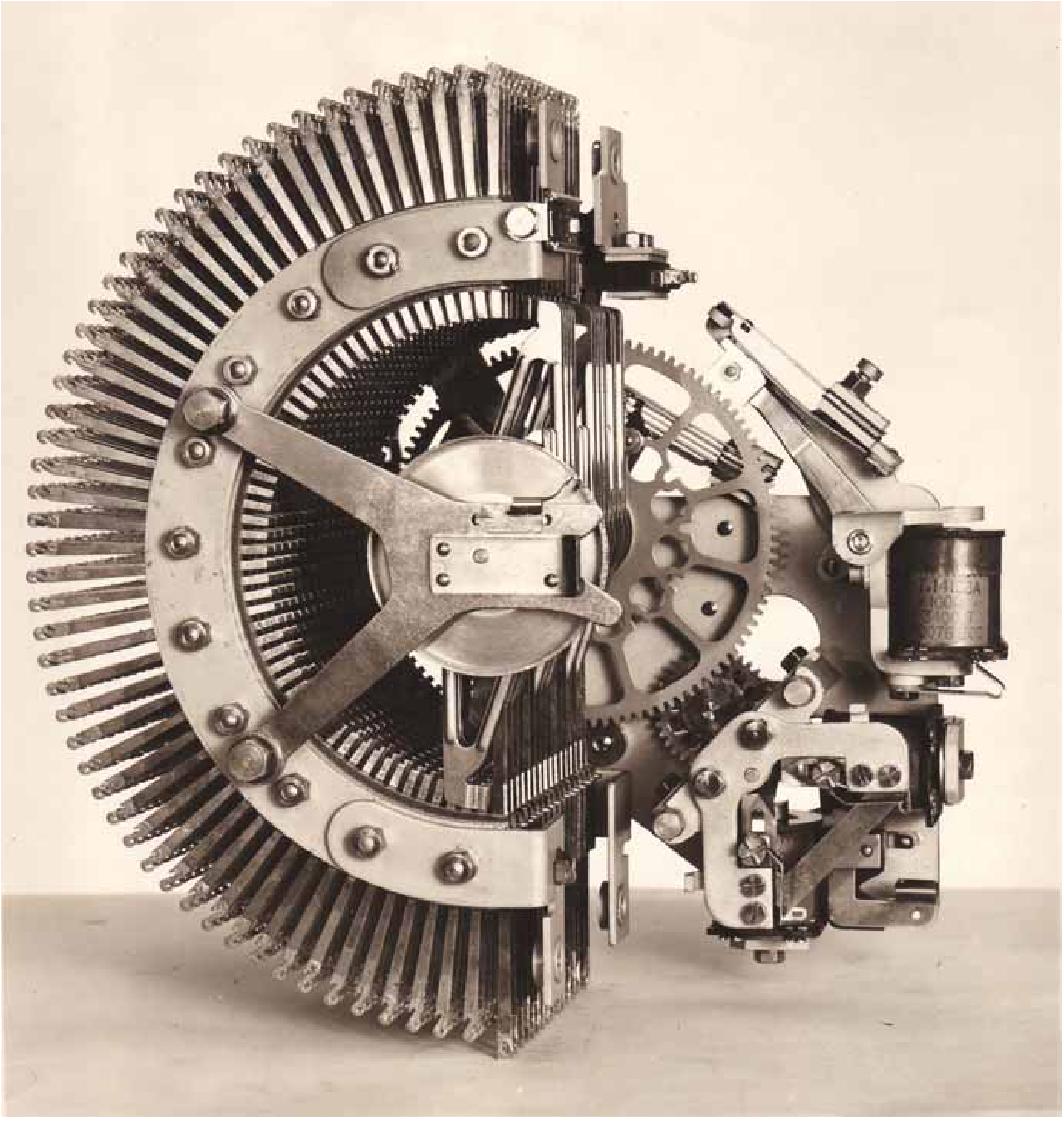

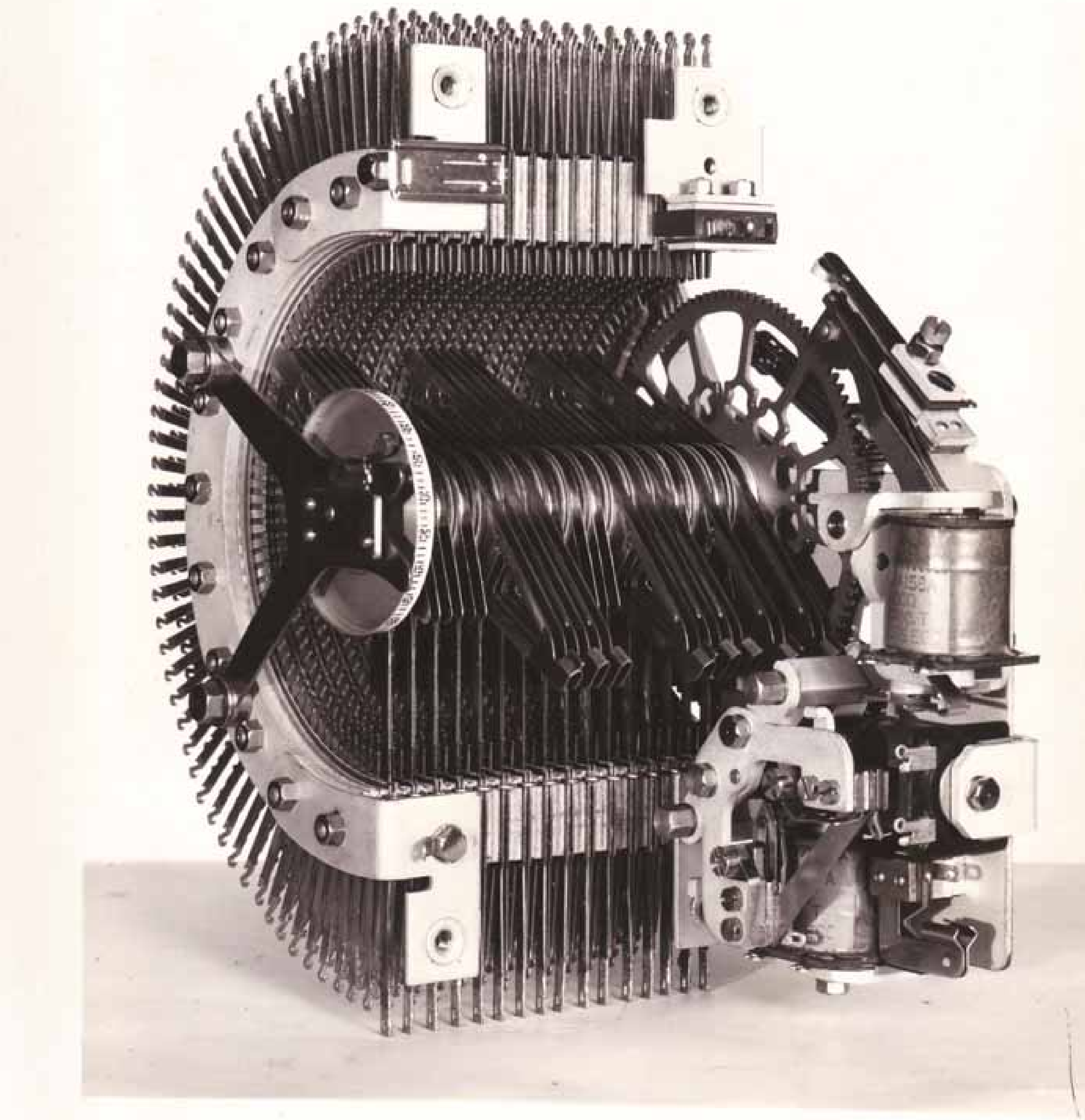

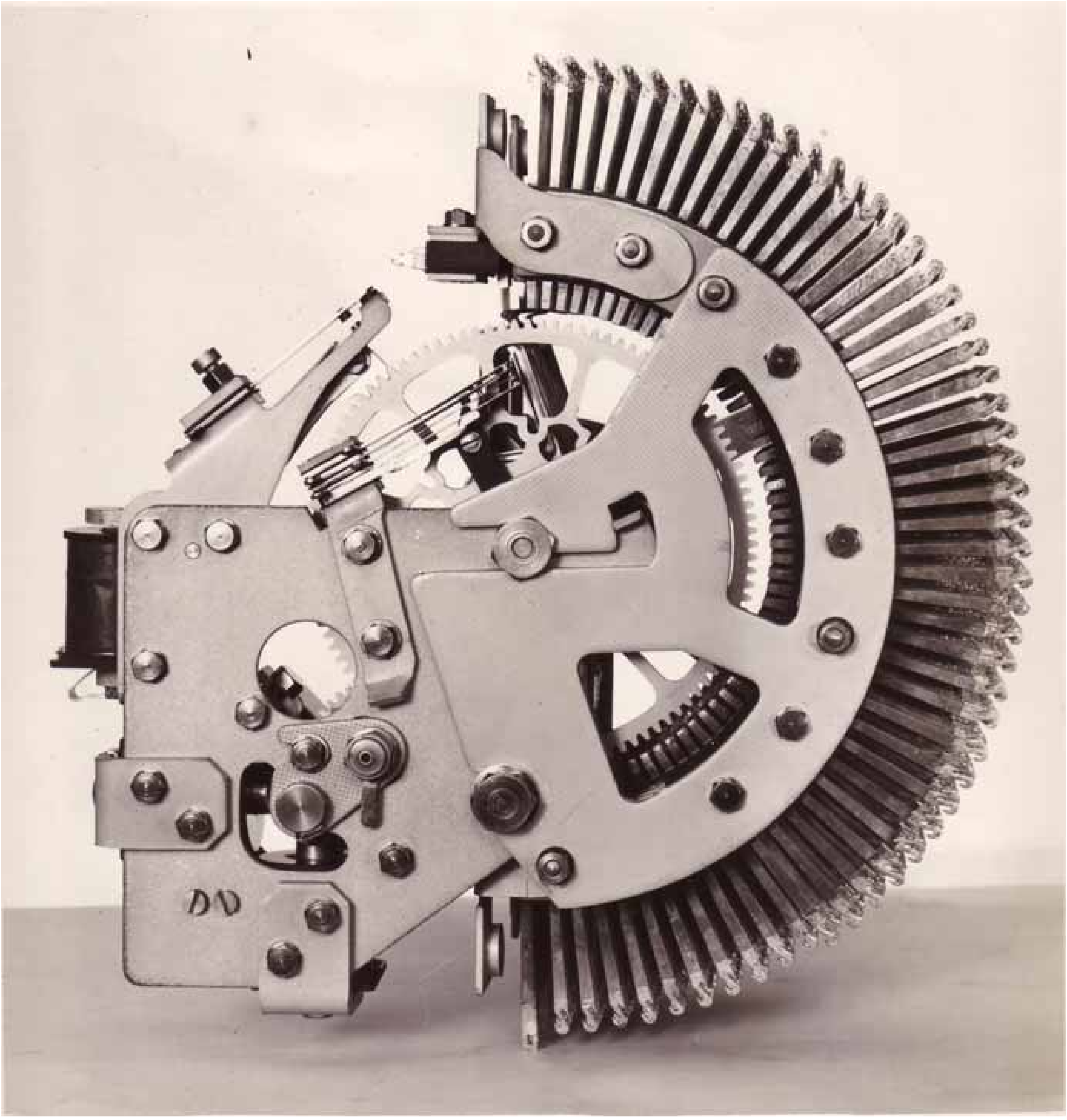
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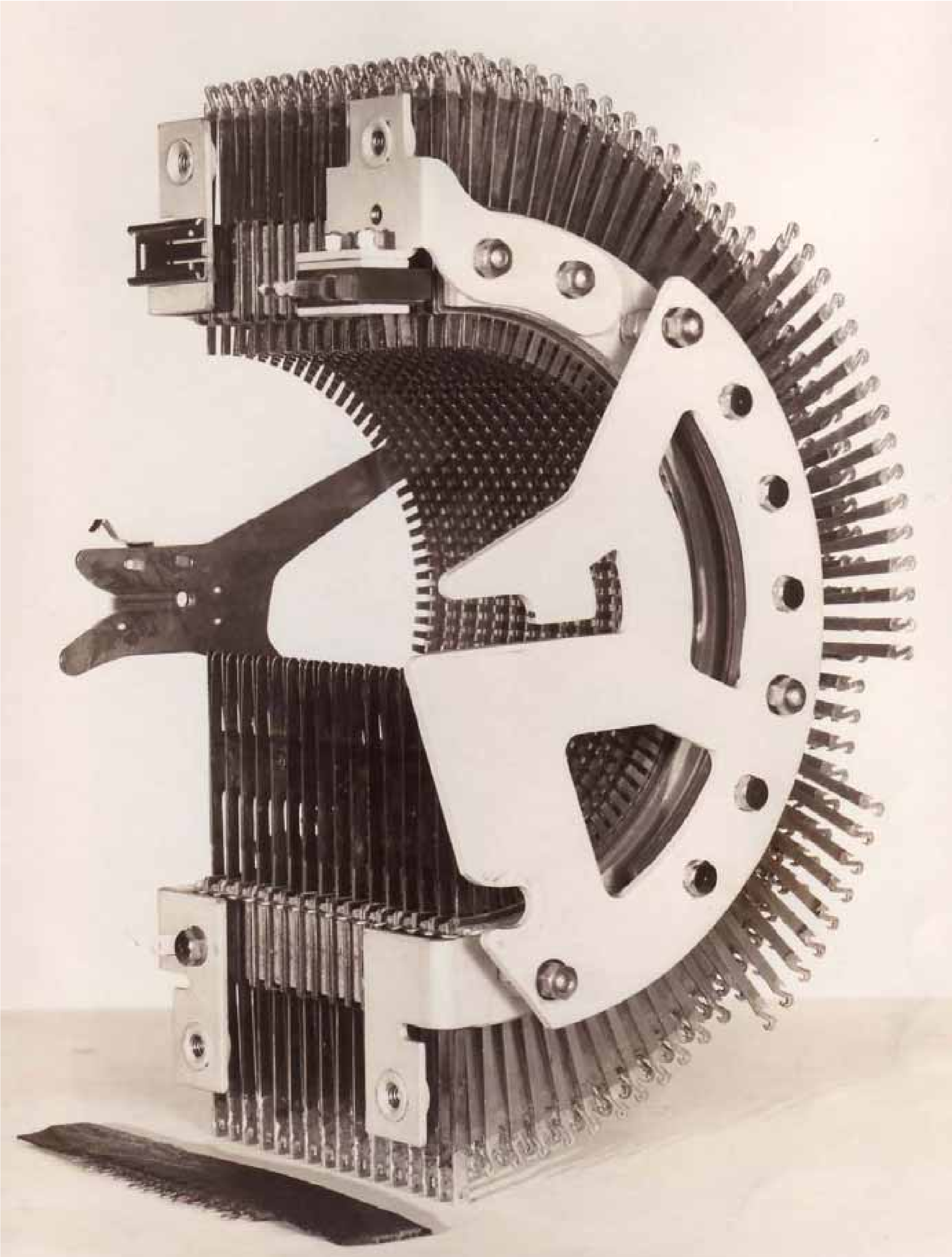

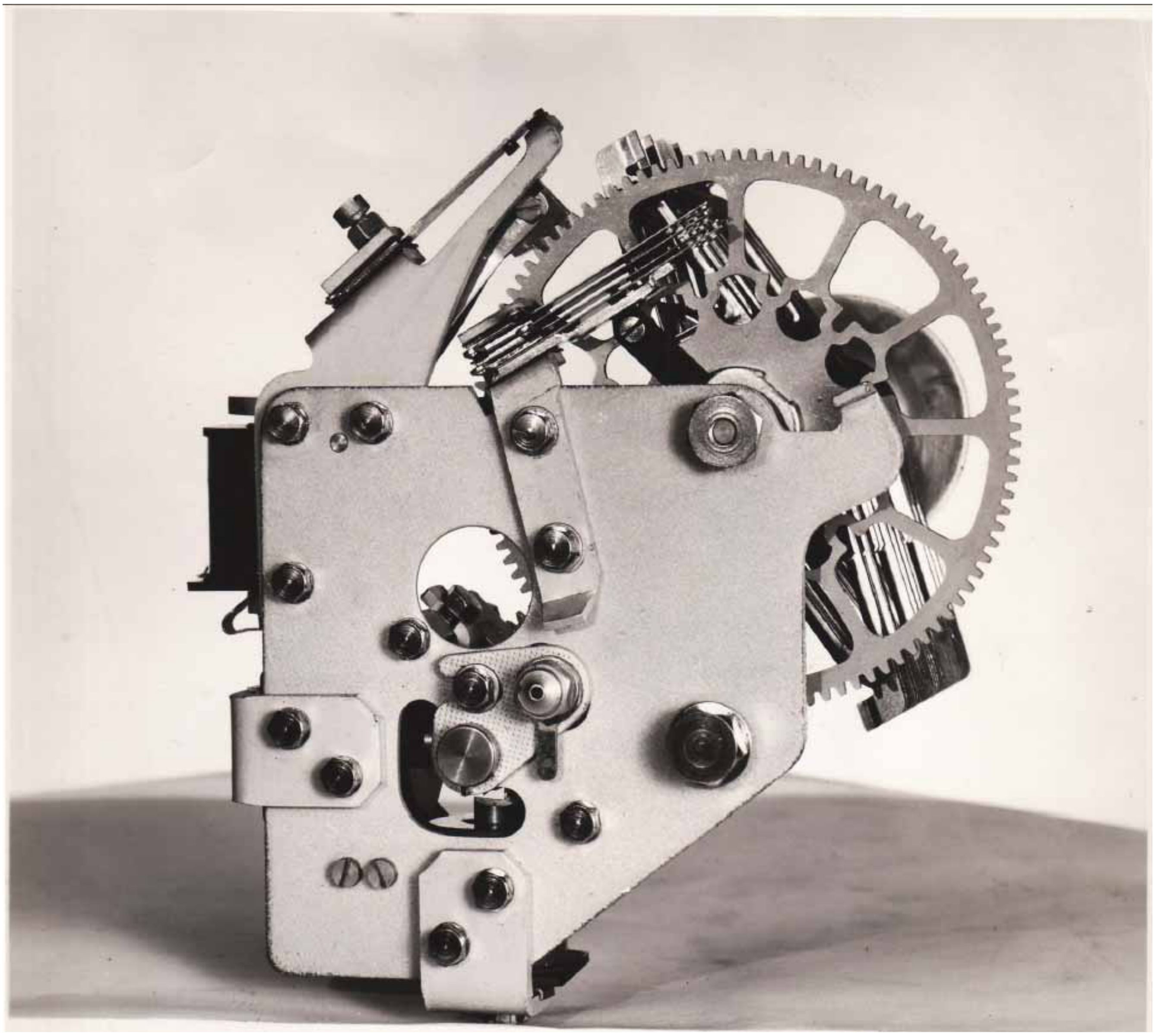

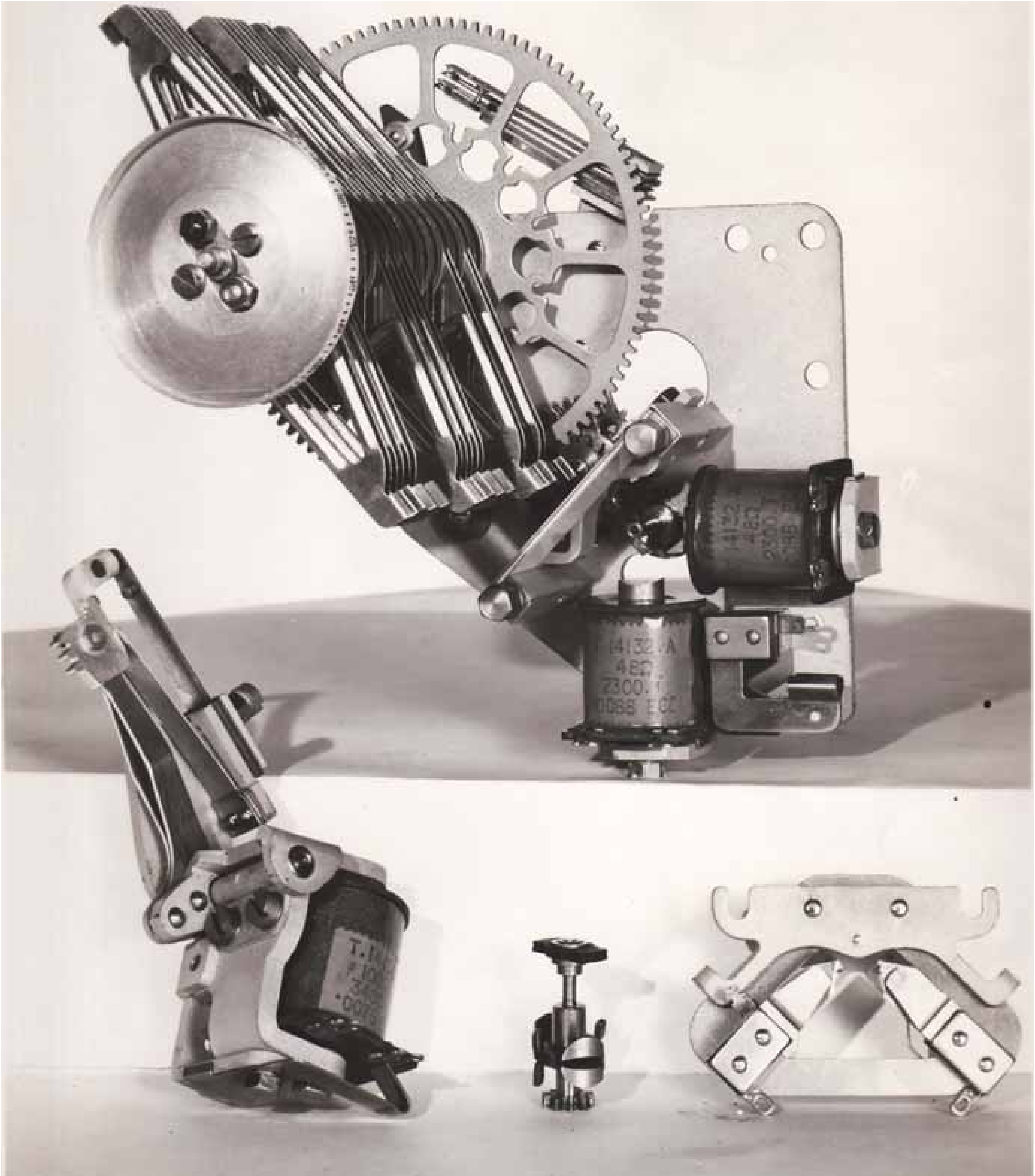

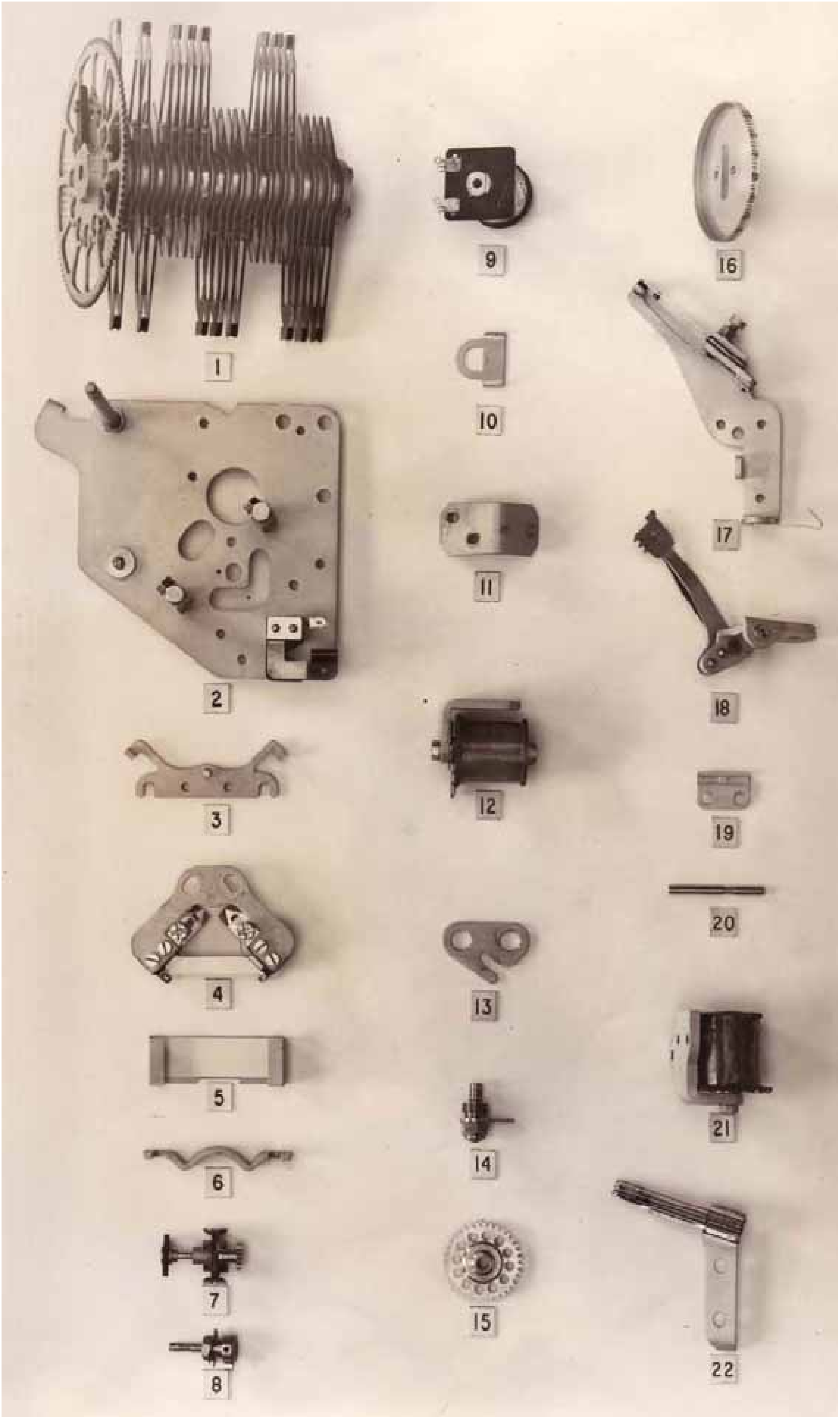
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