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COMPLETE SPECIFICATION

Improvements relating to Means for Measuring the Working Speed of Metal Tube and Extrusion Presses

We, SOCIETE ANONYME POUR L'INDUSTRIE DE L'ALUMINIUM, a Corporate Company organised under the laws of Switzerland, of Chippis, in the Canton of Valais, Switzerland, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

With metal tube and extrusion presses it is of high importance for satisfactory pressing that a definite delivery speed of the extruded product (speed of travel through the die) and consequently a definite working speed of the press ram should be observed as accurately as possible. In order fully to utilise the capacity of the very expensive presses one must work with as high a speed as possible, but a definite limiting speed must not be exceeded, otherwise defective products are pressed. The heat generated in the die during the pressing operation is one of the factors which necessitates, especially with aluminium and aluminium alloys, a limitation of the maximum speed. If for instance the aluminium or the aluminium alloy becomes too hot during the pressing through the die, the light metal sticks to the steel of the die and the tube or the section leaves the press in jerks and becomes deeply fissured, so that a worthless product is obtained.

Apart from the necessity for rapid working it is important to maintain the speed of extrusion as constant as possible, so that the semi-product has as far as possible the same properties throughout its whole length. The observance of a constant speed is already difficult because a higher pressure is necessary at the beginning of the pressing process than towards its end.

Since many years attempts have been made to produce devices which permit the operator of the press to watch constantly over the pressing speed. The speed, however, especially the working speed of the press ram, which can be as low as 0.1 millimeters per second, does not permit the usual speed indicators to be used. If the operator has no measuring device, he is compelled to control the speed only by feel. This leads to considerable variations in the pressing speed, to an insufficient utilisation of the press, as the operator must maintain a speed which is on an average considerably below the highest permissible pressing speed, and finally to the possibility of the highest permissible speed being exceeded. There is consequently the danger that an irregular or absolutely worthless product may be obtained.

A direct measurement of the delivery speed of the extruded product is very difficult. One is therefore, for practical reasons, compelled to measure the working speed of the press ram and to calculate the delivery speed of the product from the value obtained.

A device has already been proposed with which the transmission of the movement of the press ram to an electric indicating device is effected by an electromagnetic device by which a magnet armature coupled with the press ram varies the flux which passes through a coil. The device contains an elongated housing made of magnetic material, in which an iron armature having the form of a flat rail which rests in lateral guide grooves can be moved longitudinally. A shaft which cooperates with the tie-rod of the press, is coupled with this armature. In addition there are disposed in the housing, parallel to the armature, an exciting coil supplied with direct current and an induction coil (measuring coil) connected to the indicating instrument; these coils have the elongated form of the armature and therefore a rectangular cross section, the length of the rectangle corresponding to the working stroke; they are enclosed on

[Price 2/-]

their whole length by a yoke, which is a good conductor for the magnetic field. When the armature is drawn along with the advancement of the press ram, the intensity of the magnetic field of the exciting coil, which is switched on, is varied in consequence of the movement of the armature relatively to this coil. The variation of the magnetic field increases with the speed of the press ram and consequently with the speed of the lift. It produces a corresponding tension in the induction coil, which causes the indicating instrument to deflect. The induction coil therefore measures the variation of the magnetisation of a solid core of soft iron. In an alternative construction a rotary movement is employed.

The present invention relates to an improved apparatus for measuring the working speed of tube and extrusion presses, which comprises a magnet and a solenoid.

When a magnet is moved in a solenoid, there is produced at the terminals of the coil, on rapid movements an electromotive force which is proportional to the speed of the press ram, to the flux of the magnet and to the density of the turns of the solenoid. Owing to the fact that the working speed of the ram of metal tube and extrusion presses is generally very low and that galvanometers of highest sensibility are useless in rolling mills and extrusion plants, it appeared impossible to apply the induction current produced in this way to the measurement of the working speed of the press ram. However, by using a rather large coil with a high number of turns and a relatively low electric resistance and a magnet of relatively large cross section, there is produced, even at extremely low speeds an induction current which can easily be measured with the help of a robust and quick deflecting galvanometer.

According to the invention, the apparatus comprises a magnet, a solenoid and an indicating instrument which is connected to the solenoid by means of wires. Either the magnet or the solenoid is mechanically coupled to the press ram, so that a relative movement which is equal or proportional to the movement of the press ram takes place between the two. Preferably, the magnet is coupled to the ram and disposed movably in the stationary solenoid, because the solenoid must be connected by connecting wires to the galvanometer.

Most suitably the magnet consists of a bar of magnet steel (i.e. a permanent magnet). It might be possible to utilise as the magnet an iron bar found with an insulated wire through which an electric current is passed, but this arrangement would not be so convenient.

The new apparatus is much simpler and cheaper than that first mentioned.

As the electro-magnetic forces produced are generally small the indicating instrument should perferably be a mirror type galvanometer, for instance with strip suspension. With rapid movements of the press ram, for example on the return movement after the pressing operation, there are produced electro-motive forces which greatly exceed the range of measurement of the instrument and may damage it. The current must therefore be interrupted in some way or the galvanometer short-circuited when the ram has to be moved quickly. The galvanometer may be protected against rapid spurts of short duration, as occur in practice by a parallel-connected capacity. The desired protection may also be obtained by a glow discharge tube or by another suitable tube connected in parallel with the indicating instrument. The galvanometer may further be protected by one or more fuses. Finally, as the rapid movements of the ram are executed always during its operation with low water pressure, the galvanometer may be protected against over-straining in known manner by the use of a contact manometer, which switches it off by means of a relay as soon as the water pressure falls below a certain limit for instance below 50 atmospheres.

As the working speed of the press ram varies within wide limits according to the kind, the cross section and the number of the products extruded simultaneously as well as according to the metal or the metal alloy, the galvanometer is suitably provided with means for varying its sensitivity. For this purpose one can dispose in the electric circuit between the solenoid and the galvanometer resistances which may be switched on or switched off at will.

At a given working speed of the ram, the delivery speed of the product depends on its metre weight, i.e. weight per metre length, and on its specific gravity (and also on the number of tubes or sections simultaneously extruded) these variables as well as the sensitivity to which the galvanometer is adjusted must therefore be taken into account at every measurement. Of course one cannot expect the operator to make several calculations at every measurement in order to determine the delivery speed of the extruded product, or to adjust the pressing speed on the basis of similar calculations. The use of tables would be very troublesome as the cross sections of the products and

the sensitivity of the galvanometer vary in such wide limits that a table for one specific gravity would have to contain at least 10.000 numbers.

According to a further feature of the present invention, these difficulties are avoided by disposing in the induction-current circuit between the solenoid and the galvanometer a slide-rule-like device which is provided with several rod-like or circular scales and sliders or pointers and which on the one hand enables the sensitivity of the galvanometer to be varied either gradually or in steps and on the other hand automatically carries out all the mentioned calculations automatically taking into account the sensitivity of the galvanometer at the moment. The device is simplest if the scales are subdivided logarithmically. Suitably the logarithmic constant of all the scales is the same so that similar movements or similar rotations on all scales correspond to similar conditions.

The device comprises a scale which corresponds to the deflections of the galvanometer. The carrier of this scale regulates the galvanometer sensitivity by actuating contacts. The divisions of another scale correspond to the metre weights of the product, further divisions of further scales to the specific gravities of the materials to be extruded. Instead of these two scales a scale may be used the divisions of which correspond to the cross sections of the extruded semi-products. A further scale may take into consideration the number of the simultaneously extruded sections. Finally, there is scale with divisions corresponding to the delivery speed. The device comprises furthermore a number of cursors and pointers which are in part fixed in position, in part connected to the scales to move with them, and in part movable on the scales. Other arrangements of these scales, cursors and pointers are also possible and may be used for the purpose of the invention.

When the apparatus is used one first adjusts on the respective scales the metre weight of the section to be produced, and, if necessary, the specific gravity and also the number of sections. Now two cases may occur:—

(1) The galvanometer deflection which corresponds to a prescribed delivery speed has to be determined.

(2) The delivery speed of the press at any time has to be measured.

In the first case one sets the prescribed delivery speed on one of the scales, adjusts the galvanometer to a suitable sensibility and reads on another scale the amount of the galvanometer deflection which has to be observed hereafter by the operator. In the second case one reads the deflection of the galvanometer, after having, if necessary, adjusted it to a suitable sensibility, sets this deflection on a scale and reads on another scale the delivery speed.

The accompanying drawing shows diagrammatically by way of example, and not to scale one form of apparatus according to the invention.

1 designates a rod-like steel magnet with a cross section of 1600 mm^2 and a length of 2 metres, which produces a magnetic flux of 135.000 Maxwell. Its S-end is inlet in a sliding part, which is rigidly coupled with a cross-head 2. The N-end of the magnet is provided with a roll 3 made of synthetic resin, which roll supports this end in the solenoid 4; this support is sufficient in view of the long lever arm. The solenoid consists of 6 layers of 3.3 mm. diameter aluminium wire insulated by cotton (18 turns per centimetre), which is coiled on an aluminium tube. It is mounted in an iron tube 5 and connected to a slide-rule-like device 9 and a mirror galvanometer 10 by wires 6, 7 and 8. The galvanometer has strip suspension and is protected against vibration by means of an elastic suspension for its housing. It is provided with an unusually large mirror, which is disposed uprightly for the purpose of reducing the moment of inertia, and is illuminated by a 100 Watt lamp. The galvanometer may be placed on a desk and its scale 11 (a 1 metre long, diffuse reflecting strip of aluminium sheet) may be fixed to the housing of the press. The operator standing behind the control wheel and levers can easily see the light spot on the scale at all times. The arrangement may be such for example that a working speed of the press ram of 0.1 mm per second causes a deflection of 25—30 centimetres when the galvanometer is adjusted to its maximum sensitivity.

The slide-rule-like device comprises three movable slides on which the divisions are marked in equal logarithmic scales the length of one decade being 20 centimetres. On the first slide 13 there is a scale corresponding to the galvanometer deflections, on the second slide 14 a scale of metre weight and on the third slide 15 a scale of delivery speeds on the upper side and a scale of specific gravities on the lower side. A displacement of the slide 13 automatically effects (through contacts and resistances not shown) step by step variations of the galvanometer sensitivity, the relation of one sensitivity to the next being 1 to $\sqrt{10}$. On the slide 14 there is a cursor 16 which is movable

along it but moves with the slide when the latter is moved. This cursor is provided with a line which simultaneously indicates a galvanometer deflection on the scale of the slide 13 and a weight on the weight per metre scale of the slide 14. A cursor or index 17 is fixed on the slide 14 and its pointer reads on the scale of delivery speeds on the upper part of the slide 15. A pointer 18 which is immovable during all operations points to the scale of the specific gravities on the lower part of the slide 15. Before beginning the measurement this slide 15 is so adjusted, that the pointer 18 indicates on it the specific gravity of the material to be extruded. If the number of the simultaneously extruded sections must also be taken into consideration by the device, the pointer 18 is movably mounted on a fixed scale not shown on the drawing which carries, still in the same logarithmic scale, the even numbers from 1 to 10 or 20. Furthermore the cursor 16 is adjusted on the slide 14 to the metre weight of the sections to be pressed. All scale divisions are parallel and the figures on them increase from the left to the right.

If the galvanometer deflection corresponding to a prescribed delivery speed is to be determined, the slide 14 is moved until the cursor 17 is set to the prescribed delivery speed. In this manner the result is obtained that the cursor 16 indicates on the slide 13 the galvanometer deflection which has to be observed. If this deflection is too small, or if the cursor 16 comes outside the scale on the slide 13, this slide is moved step by step until a suitable deflection is obtained. At each complete step a spring snaps into one of a number of notches which are disposed on the back of the slide. The variation of the galvanometer sensitivity caused by this operation need no longer be considered by the operator, who merely has to operate the control levers in such a manner that the light spot of the galvanometer is always on the number of the scale 11 which the cursor 16 indicates on the scale of the slide 13, so that the section is delivered at the desired speed.

In the second case, the operator reads the position of the galvanometer light spot on the scale 11 after having, if necessary, adjusted the galvanometer to a suitable sensitivity by moving the slide 13, and moves the slide 14 until the cursor 16 indicates on the slide 13 the number corresponding to the galvanometer deflection on the scale 11. Now the cursor 17 indicates on the upper scale of the slide 15 the delivery speed of the extruded section.

If has been found in practice that the operators can utilise the device readily, even if they do not understand the use of the slide rule. In order to facilitate manipulation it is desirable to number as many divisions of the scales as possible to indicate the position of the commas or decimal points, and to subdivide the interspaces only in halves and tenths, but not fifth parts.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A apparatus for measuring the working speed of metal tube and extrusion presses comprising a magnet movable axially in a solenoid, and an instrument for indicating the induction current produced, which instrument is electrically connected to the solenoid winding, the apparatus being connected to the press ram in such a manner that movement of the ram effects movement of the magnet relatively to the solenoid.

2. An apparatus according to claim 1, in which the indicating instrument is a galvanometer.

3. An apparatus according to claim 2, in which the galvanometer is a mirror galvanometer.

4. An apparatus according to claims 1, 2 or 3, in which there are connected between the solenoid and the indicating instrument resistances which can be switched on or off so as to vary the sensitivity of the indicating device.

5. An apparatus according to claim 4, in which the resistances can be switched on and off through the operation of a slide-rule-like device, which is provided with several slides or discs and cursors or pointer so arranged that the delivery speed of the extruded product can be determined in a simple manner taking into consideration the metre weight, the number of the simultaneously extruded sections, the specific gravity of the material to be pressed and the momentary sensitivity of the indicating instrument.

6. An apparatus according to any preceding claim in which the indicating instrument is protected against heavy surges of current by means of a capacity connected in parallel.

7. An apparatus according to claim 1, in which the indicating instrument is protected against overvoltages by a glow discharge tube or glow discharge lamp.

8. An apparatus according to claim 5, in which the slide-rule device comprises a number of scales with the necessary cursors or pointers, the carrier of one scale which corresponds to the deflections of the indicating instrument being provided

with contacts which when the carrier is moved cause the switching on and off of electric resistances in the current circuit and therefore a variation of the sensitivity of the indicating instrument, whereas on the other scales the remaining variables are taken into account one of these scales being subdivided according to the delivery speeds of the extruded sections.

9. A device according to claim 8, which is provided with scales of the sensitivity of the indicating instrument, of the metre weights of the sections to be extruded, of the specific gravities of the material to be extruded and of the delivery speeds of the extruded section.

10. A device according to claim 9, which is provided also with a scale of the number of the sections to be extruded simultaneously.

11. A device according to claim 8, which is provided with a scale of the sensitivity of the indicating instrument, of the cross sections of the products to be extruded and of the delivery speeds of the extruded sections.

12. A device according to claim 8, characterised by the fact that it is provided with scales of the sensitivity of the indicating instrument, of the cross sections of the products to be extruded and of the delivery speeds of the extruded sections.

13. Apparatus substantially as described.

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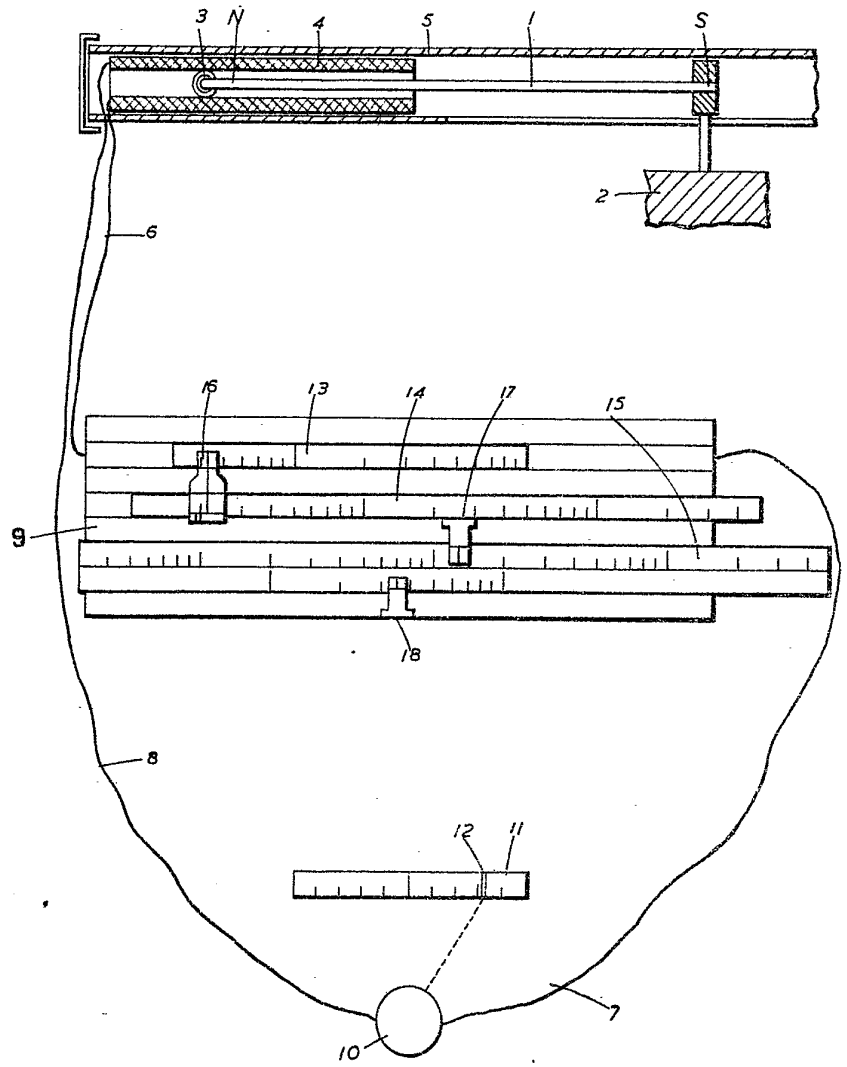

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