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Technical Report No. 26

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NEW MECHANICAL EQUIPMENT FOR HANDLING OCEANOGRAPHIC CABLES

1. A MINIATURE SLIP RING INSTALLATION
2. A LIGHT-WEIGHT PULLEY
3. AN ELECTRICAL AND A MECHANICAL SWIVEL

by

R. FRASSETTO, V. MANZOTTI, and A. CHIARABINI

21 APRIL 1964

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LA SPEZIA, ITALY

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APPROVED FOR DISTRIBUTION

HENRIK NØDTVEDT
Director

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INTRODUCTION

The four pieces of equipment described in this report have been designed to facilitate the handling of oceanographic cables by replacing the heavy, and often expensive equipment at present in use with lighter, less expensive units.

They consist of (a) a miniature slip ring installation for multi-conductor cables that considerably improves the signal-to-noise ratio; (b) a light and sturdy pulley that swings freely with the movement of the cable, thereby reducing chafing and breaking; and (c) two compact swivels, one being for use with electric cables.

AN INEXPENSIVE, LOW-NOISE, MINIATURE SLIP RING INSTALLATION FOR MAINTAINING CONTINUOUS ELECTRICAL CONTACTS THROUGH OCEANOGRAPHIC WINCHES

By

R. Frassetto and A. Chiarabini

One of the problems in telemetering continuous measurements from shipborne oceanographic instruments is that of ensuring electrical continuity with the conductor cables as they revolve on the winch. For this purpose, slip-rings are adapted to the winch, but they are usually of massive construction and introduce unwanted electrical noise often capable of masking incoming signals. The slip-ring installation to be described has been designed and built at this laboratory to overcome this latter difficulty.

As the noise made by a slip-ring assembly is directly proportional to the distance travelled by the brushes and to the roughness of their travel, it is possible to reduce this noise by using smaller and smoother rings and more precise assemblies. Miniature slip-ring assemblies with these characteristics are now manufactured in bulk for use in computers, gyros, etc., and have been used as the basis of the present installation. In addition to improving electrical continuity they also effect an important saving in cost and space.

Figures 1, 2 & 3 show the installation. It is capable of handling up to 24 conductors and of being introduced easily into a winch axis (a). The standard, miniature slip-ring assembly, (f) & (g), chosen as its basis has gold-plated rings and gold alloy wire brushes; the axis of the rings revolves within two ordinary ball-races (d). The quality of electrical continuity obtained by the use of this assembly is maintained through commercially available, gold-plated multi-contact connectors at both input (b) and output (h). The complete installation is housed within a moisture-proof, transparent, Lucite casing (e), the side of which can be removed to facilitate maintenance and repair. Attachment to the axis is by a knurled retaining sleeve (c).

The design permits the installation to be connected and disconnected rapidly: an advantage when the winch has interchangeable spools. Its design also makes it easily adaptable to most existing forms of oceanographic winch. The result is a sturdy, inexpensive* and practical device, with minimum electrical noise.

SPECIFICATIONS

Slip-ring and Brush Assembly

Manufactured by I.D.M. Electronics Ltd., U.K., as part of their standard range, and obtainable with from 2 to 24 ways. The installation described can be fitted with any of these sizes.

The rings are of 0.13 mm thick, hard, fine, electrodeposited, 24-carat gold; the brushes are of 0.193 mm diam. gold alloy wire. The maximum continuous current is 250 ma. rms per circuit and the maximum working voltage between circuits is 250 v. rms. The insulation resistance between all circuits is better than 200 meg at 500 v. DC.

Electrical Connectors

Manufactured by Amphenol-Borg Electronics Corp., U.S.A. They are environmentally resistant and can have gold-plated contacts; coupling is by thread.

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*A 10 conductor unit built in this laboratory cost about 50 dollars for all its parts.

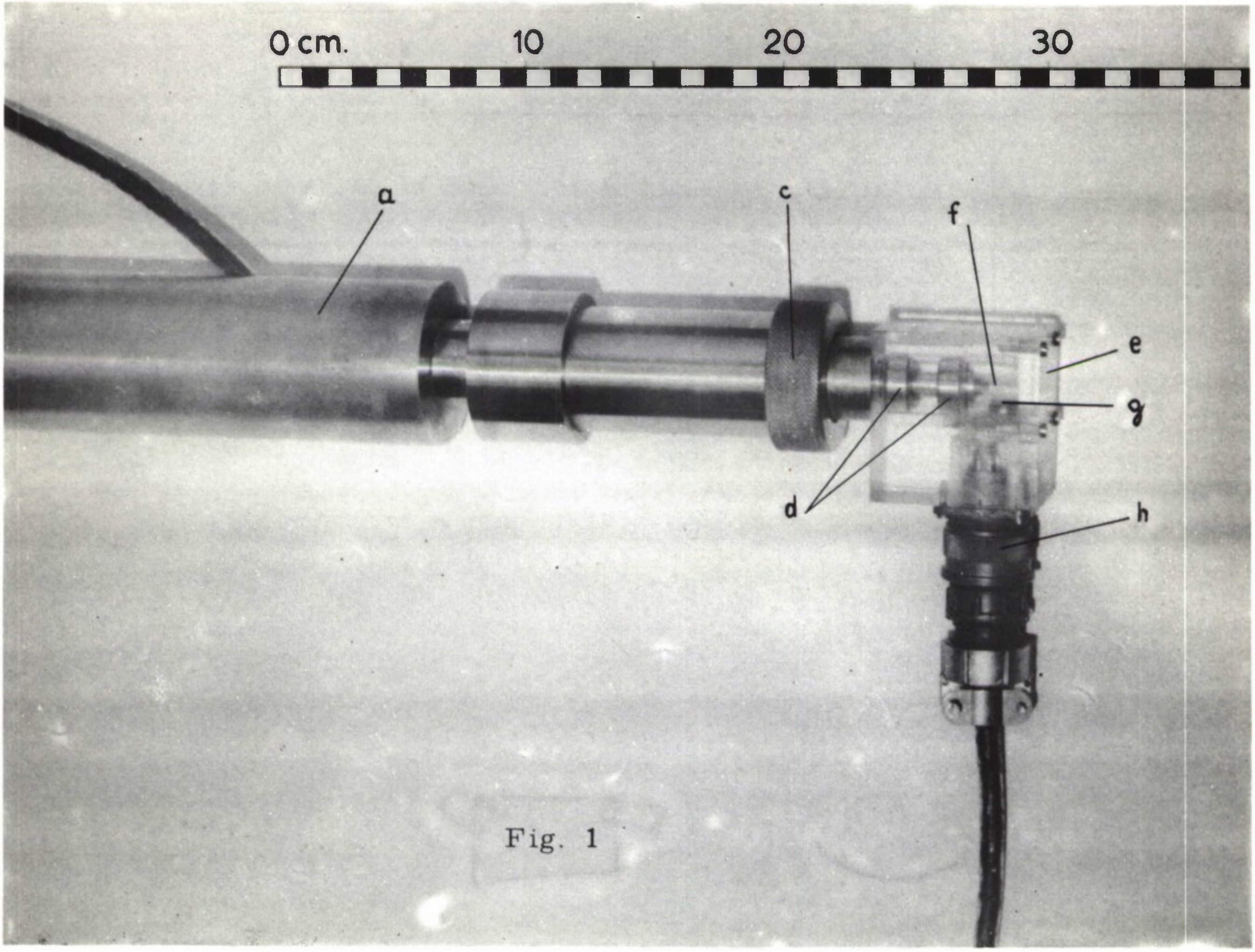


Fig. 1

The miniature slip-ring installation mounted on a winch axis (a). The slip-rings (f) turn with the axis and revolve on bearings (d). Their brushes (g) are attached to the Lucite housing (e) which is held steady by the output cable and its multi-contact connectors (h). The input cable enters through a hole in the winch axis to join an identical pair of connectors inserted in its end. The installation is held in place by the retaining sleeve (c).

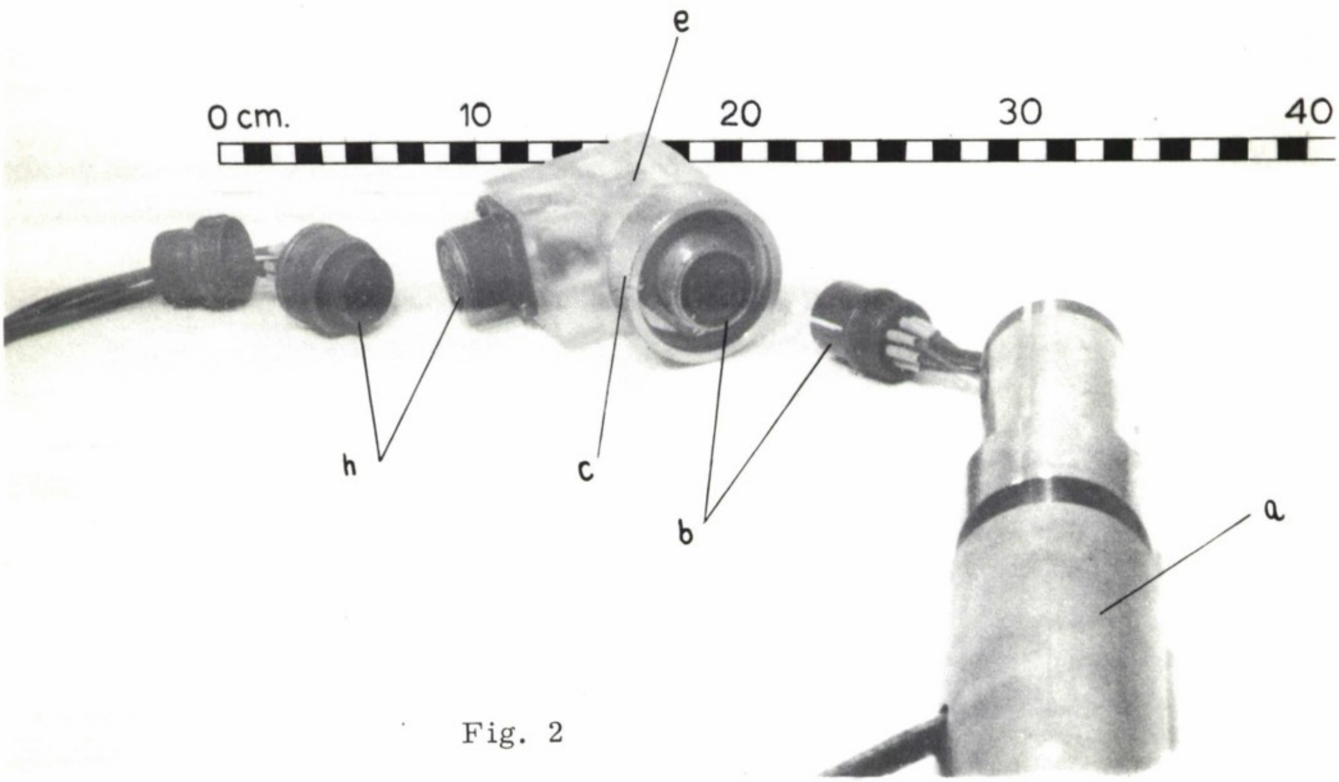


Fig. 2

The miniature slip-ring installation detached from the winch axis and from the inlet and outlet cables. The multi-contact connectors, (b) & (h), and the method of attachment by the retaining sleeve (c) are shown.

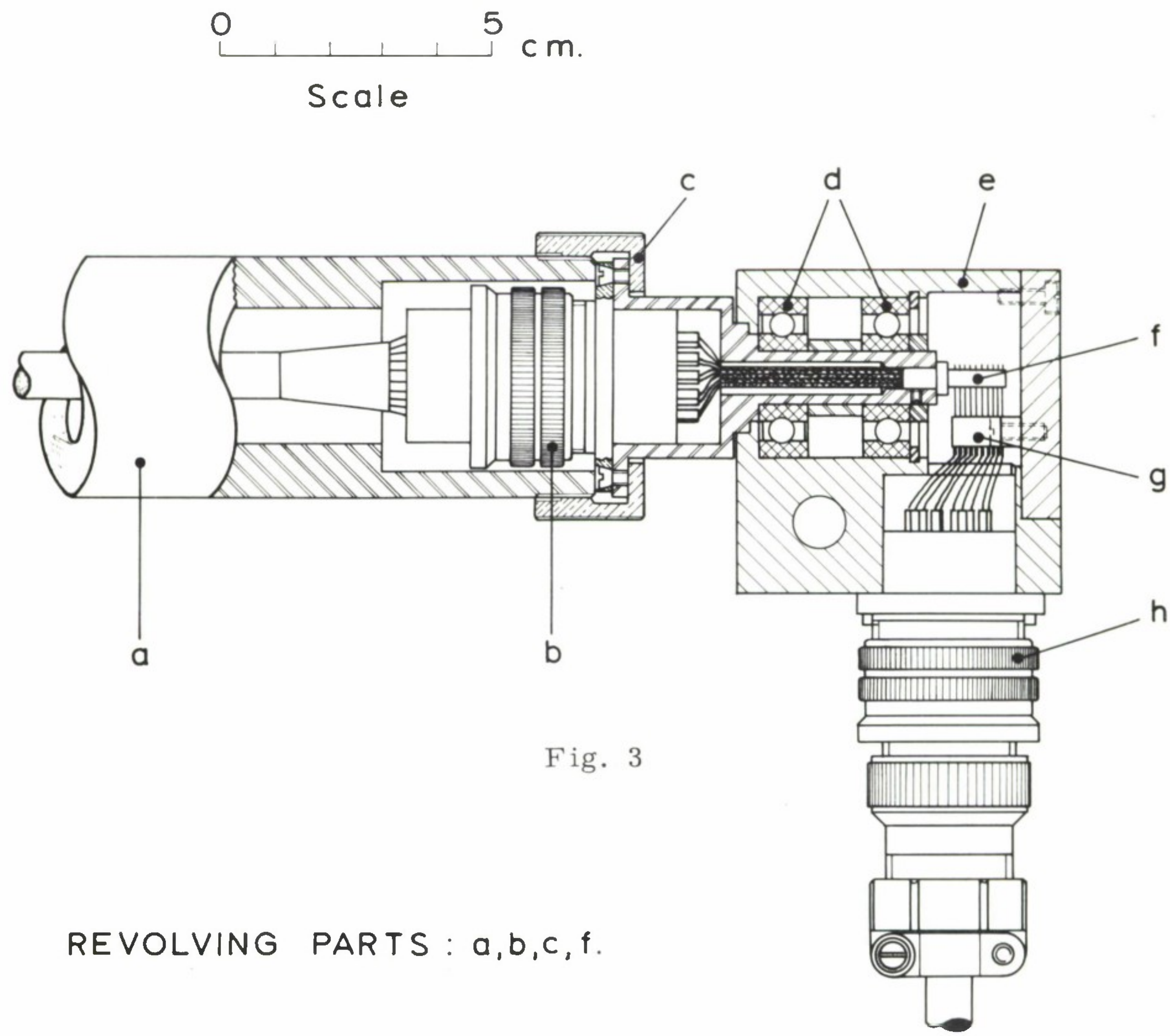


Fig. 3

Drawing of the miniature slip-ring installation in place: (a) winch axis adapted to receive the installation, (b) multi-contact input connector with gold-plated pins, (c) screw-threaded retaining sleeve, (d) bearings, (e) Lucite housing, (f) miniature slip-rings turning with the winch axis, (g) miniature brushes fixed to the non-revolving housing, (h) multi-contact output connector with gold-plated pins.

A LIGHT AND STURDY PULLEY, WITH INTERCHANGEABLE WHEELS, FOR USE WITH OCEANOGRAPHIC MULTICONDUCTOR CABLES

By

R. Frassetto and V. Manzotti

Breaking of an oceanographic cable often occurs at the pulley over which it is being streamed, because the pulley tends to remain vertical instead of conforming to the horizontal component of the cable's streaming angle. The pulley described has been designed and built at this laboratory to overcome this fault. In the proportions given it is suitable for use with multiconductor cables having plastic jackets and steel rope cores with a minimum radius of curvature of 15 cm, and for the raising and lowering of instruments of a total weight of up to 1000 kg; the principles used may be applied, however, to other sizes of pulley.

The pulleys usually employed are heavy and have their centre of gravity well below the line of the cable. The moment of forces around the supporting hook thereby favours the pulley, so that it resists the sideways pull of the cable and tends to remain vertical; when the sideways angle reaches a certain value the cable rides up out of the groove and becomes blocked in the bracket (Fig. 1a).

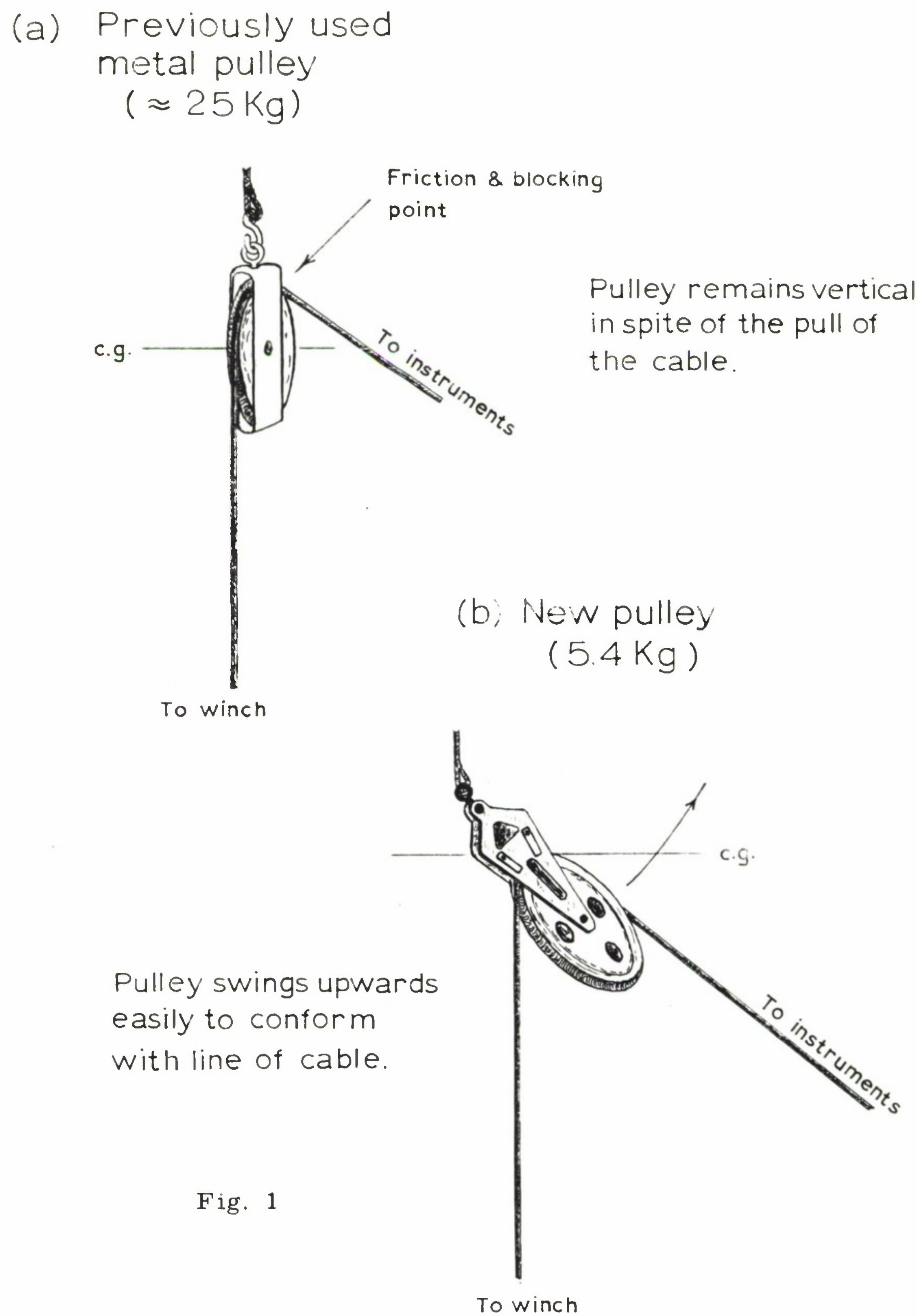
In the pulley described, these combinations have been changed in favour of the cable. This has been done by reducing the weight of the pulley to 5.4 kg (compared with about 25 kg for commercially available oceanographic pulleys of this size, but made entirely of metal) and raising its centre of gravity to above the line of the cable. This reduces its resistance to the sideways pull of the cable, so that it is swung easily into line (Fig. 1b). Tests with this model show that a pull of only 14 kg is sufficient to bring it into line with a cable streaming sideways at 45°, and one of only 18 kg when the cable is at 65°.

The pulley is illustrated in Fig. 2. Weight reduction was achieved by the use of light-weight "Segaleo" (a laminated resin with strong mechanical characteristics) for the 30 cm internal diameter wheel (e), and anodized "Anti-corrodal" aluminium for the bracket (b). The upper part of the bracket is longer than usual, in order to raise the centre of gravity above the line of the cable, but its total weight is reduced by the use of a simple triangular structure of high strength-to-weight ratio. It is suspended from a swivelling eye-bolt (a).

By making the groove especially deep (2.4 cm to cable centre), the cable is presented with an enlarged area against which it can push the pulley into line. The groove is also tapered (see details in Fig. 3) in a fashion that tends to return the cable if it should become accidently unseated.

The cable is placed over the wheel by releasing two wing nuts (c, c) and revolving one side (d) of the bracket around the axle. The wheel can be changed by proceeding in the same way and then removing one of the stainless-steel axle nuts (f). The nut on the other side of the axle (see detail in Fig. 3) is of the self-lubricating type. As the wheels are cheap and easily removed, it is convenient to carry only one bracket and a set of interchangeable wheels having grooves suited to each required cable diameter. At present, three wheel sizes have been made; to accommodate cables of 4-6 mm, 8-9 mm, and 10-12 mm diameter. The mechanical drawing in Fig. 3 shows details of the construction, including sections of three different pulleys.

A pulley of this design has been used successfully at sea.



(a) Previously used metal pulley (≈ 25 Kg)
Friction & blocking point
Pulley remains vertical in spite of the pull of the cable.
c.g.
To instruments
To winch
(b) New pulley (5.4 Kg)
c.g.
Pulley swings upwards easily to conform with line of cable.
To instruments
To winch

Fig. 1

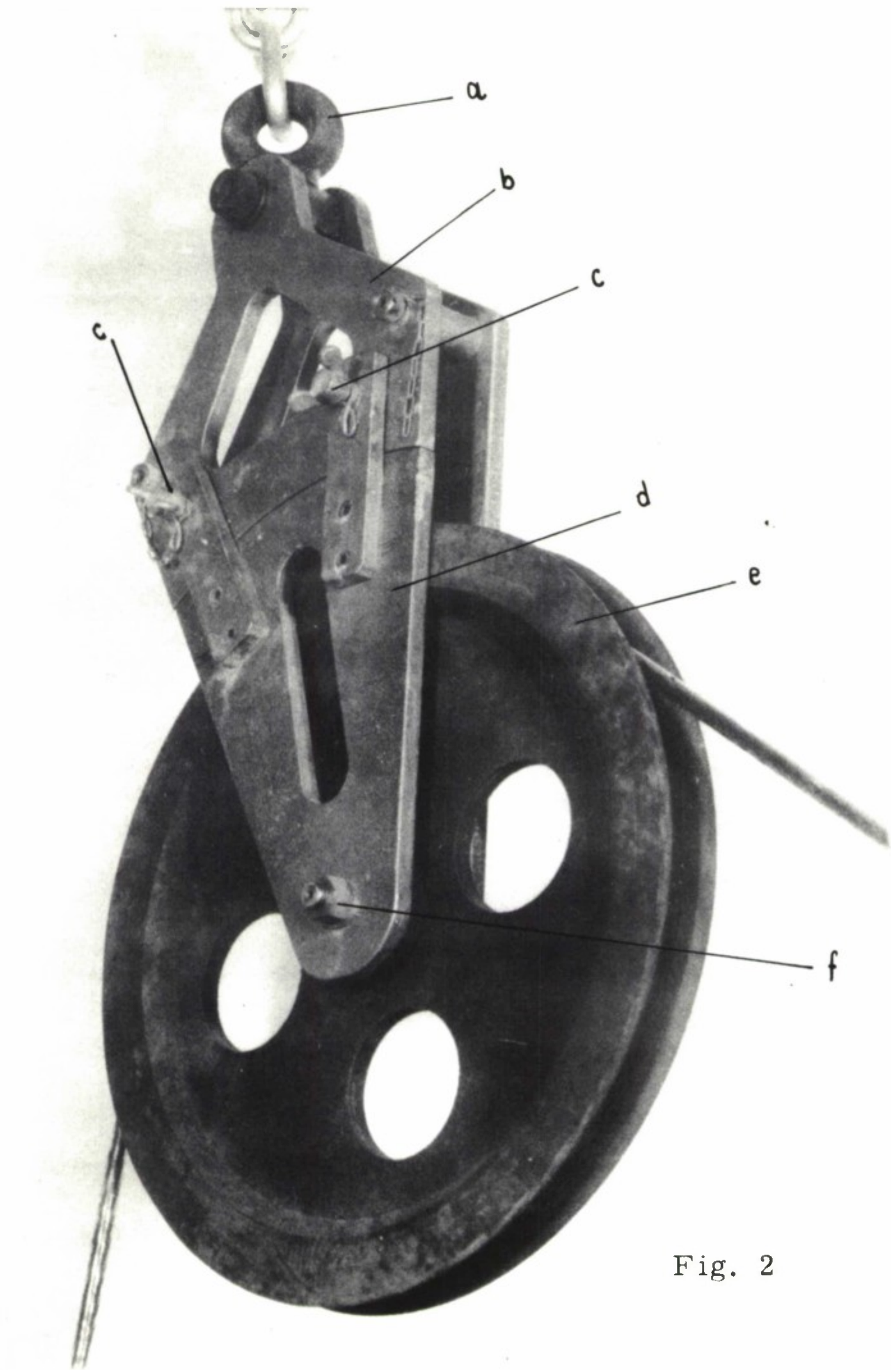


Fig. 2

The light-weight oceanographic pulley. The laminated resin wheel (e) is supported by a triangular frame bracket (b) of aluminium. By releasing the wing nuts (c, c) one side (d) of the bracket revolves around the axle (f) to permit entry of the cable. The whole is supported by a swivelling eye-bolt (a) and swings freely in all directions with the pull of the cable

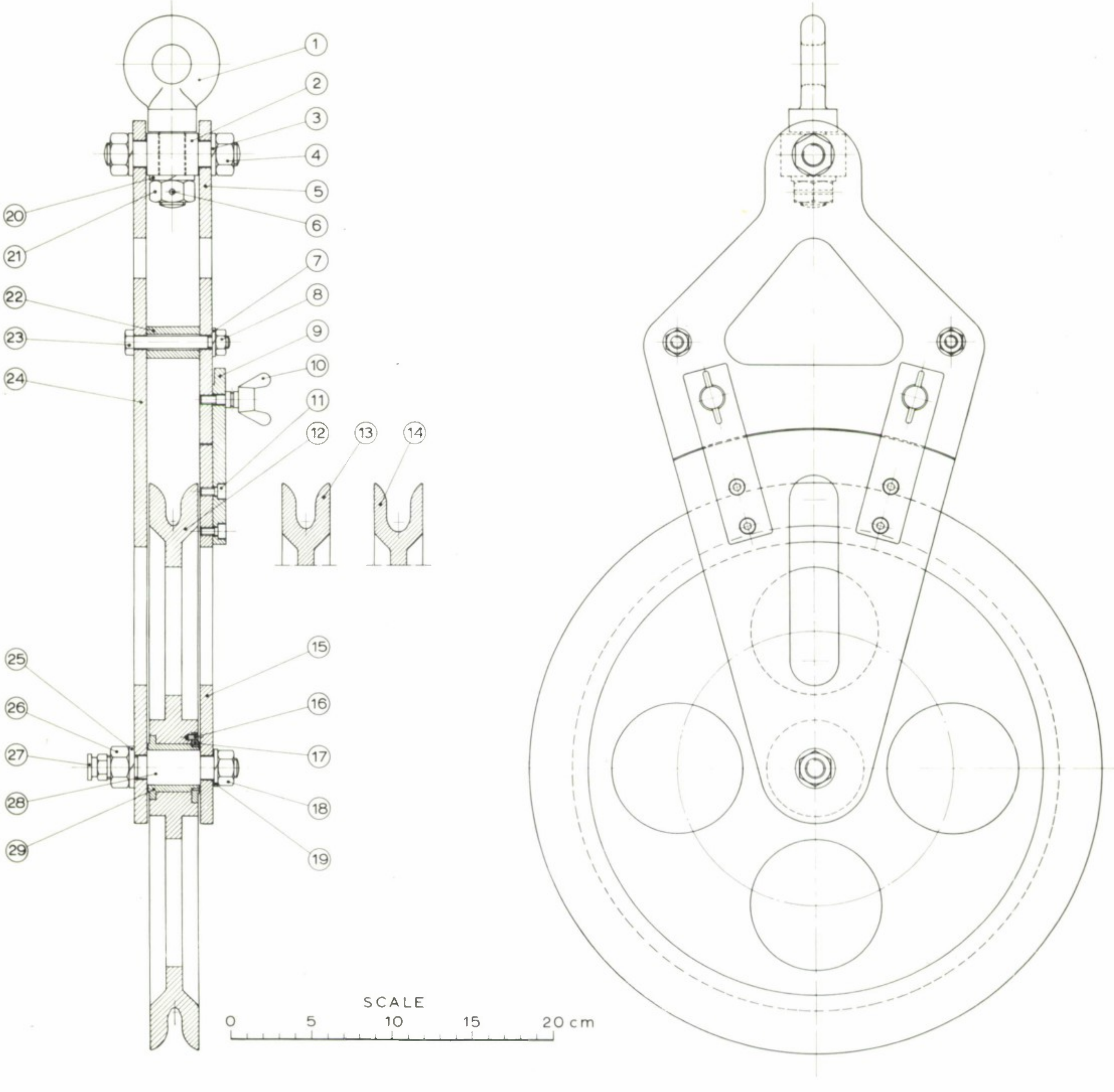


Fig. 3

Mechanical drawing of the pulley. The wheel, shown in three sections (12, 13 & 14) for cables of Ø6, Ø9, & Ø12 mm, is made of laminated resin. The two fixed sides of the bracket (5 & 24), its revolving section (15), and the retaining arms (9) are of anodized aluminium. The axle revolves within a phosphor bronze sleeve-bearing (29). All other parts are of stainless steel. The self-lubricating axle nut, not visible in Fig. 2, is shown here (27).

TWO COMPACT SWIVELS - ONE SOLELY MECHANICAL AND THE OTHER WITH ELECTRICAL CONNECTIONS - SUITABLE FOR OCEANOGRAPHIC CABLES

By

R. Frassetto and V. Manzotti

The swivels currently used in deep ocean work tend to be bulky and unwieldy. For lubrication and electrical insulation they generally use oil, which, being fluid and lighter than water, tends to escape and to be replaced by sea water, thereby introducing serious problems. The models described in this report have been designed and built in this laboratory to obtain greater compactness and reliability by using viscous, electrical-insulating petrolatum in place of oil.

Figures 1, 2 & 3 illustrate the two designs, the smaller swivel being for mechanical linking and the larger for the linking of cables that incorporate a single electrical conductor. As can be seen from the scale, both are compact. They both revolve on ball-bearings, lubricated and insulated from sea water by petrolatum directly exposed to external pressure. Their design is of maximum simplicity.

Electrical Swivel (Figs. 1 & 2)

For lightness in water, the tube and two end-plugs forming the swivel housing (d) are made of 0.9 density polipropilene. They are held together by stainless steel end plates (b) and retaining bolts (c), which, together with the stainless steel lugs (a) and the swivel pin assembly, take all the tension. The swivel pin (n) passes through a hole into the centre of the housing, where a nut (m) holds it against pressure bearings (g) treated with molibdene bisulphide, thereby allowing it to rotate freely with respect to the housing. An "O" ring (o) prevents entry of sea water along the pin.

An electrical conductor is accommodated tightly within the hollow core of the swivel pin and terminates in a brass head (j) seated on an insulating Teflon spacer (m), which in turn is seated on the end of the swivel pin nut. A sharp point on this head maintains electrical continuity by revolving against a phosphor bronze spring (h) mounted inside the housing and connected to the other electrical conductor. Both electrical conductors lead to deep water Mecca connectors (p).

The space (e) around the swivel pin head is completely filled with lubricating and insulating petrolatum, in direct communication with the sea through a long buffer tube (f) running from the inside of the housing at y to the outside at x. The petrolatum was selected so that it is neither too fluid at surface pressure and temperatures, nor too viscous at high oceanic pressures and a deep ocean temperature of $4^{o}C$. Petrolatum with these characteristics was made empirically in the laboratory by mixing commercial "Vaseline" and "Vaseline Oil", the mixture used being approximately equal parts of each. Petrolatum also has the advantage that when liquified - at a temperature of $50^{o}C$-$60^{o}C$ in this case - it can be poured into all the interstices to eliminate air pockets.

Because petrolatum is more compressible than water, the volume required to preserve water-tightness inside the housing is maintained by the excess inside the buffer tube. The volume of this excess is more than adequate to compensate for pressures of 4000 kg/cm^2. As petrolatum is lighter than water, the seaward end of the tube turns downwards to prevent the petrolatum flowing out; this is prevented also by the bore of the tube, which is such that it resists the flow of petrolatum within the viscosity ranges that occur. The low electrical conductivity of petrolatum prevents any possibility of shorting through this tube.

The swivel measures 165 mm from lug to lug, and weighs only 460 gm in air and 295 gm in sea water. The swivelling torque is of the order of 0.01 kg-m, and loads of 1000 kg have been supported without the loss of swivelling action.

Mechanical Swivel (Figs. 1 & 3)

This swivel is constructed entirely from stainless steel. The swivel pin (e) turns on pressure bearings (c) treated with molibdene bisulphide and contained within a housing (b). Tension is maintained between two lugs, one (a) screwed into the housing as a plug and the other (a') screwed onto the swivel pin.

The housing is packed with petrolatum of the same viscosity as is used in the electrical swivel, thereby lubricating the swivel pin head and insulating it from the effects of sea water. The petrolatum's reduction in volume with external pressure is compensated for by the excess in a greasing cap (d), through which the swivel pin passes.

The length of the swivel from lug to lug is 110 mm, and it weighs 370 gm in air and 320 gm in sea water. The swivelling torque is 0.01 kg-m at 200 kg, and loads of 1000 kg have been supported without the loss of swivelling action.

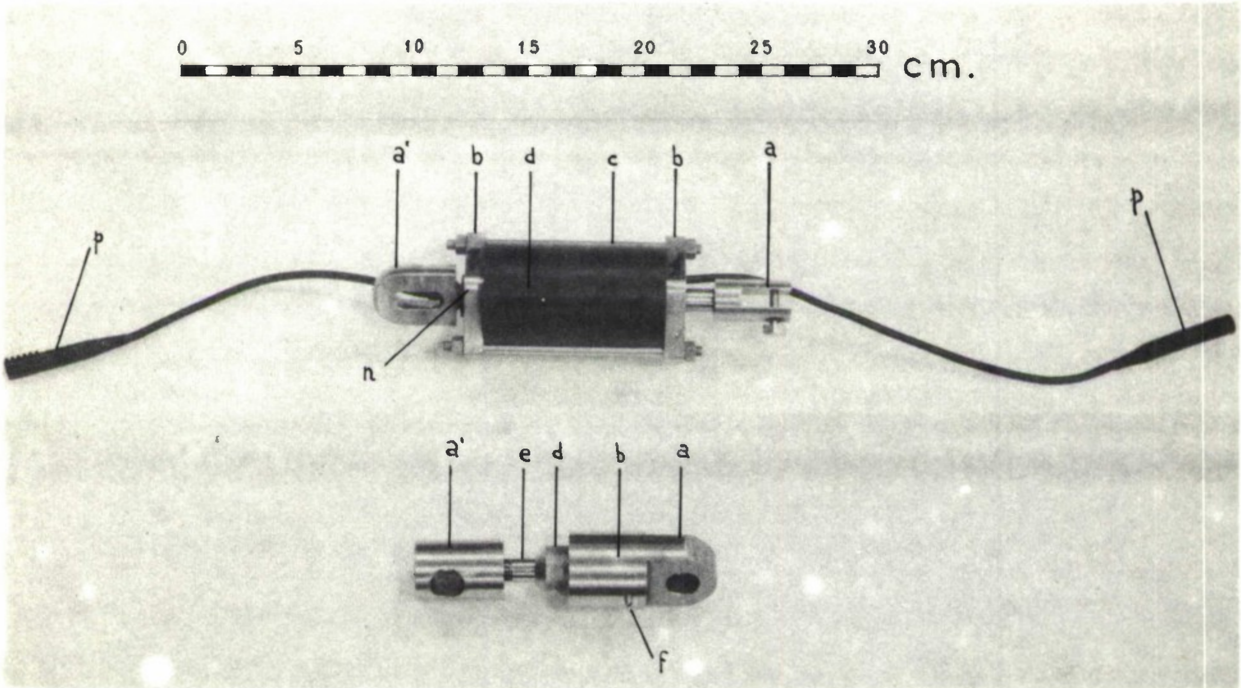


Fig. 1

The two compact deep-water swivels. The one above is for joining single-conductor electrical cable; its lugs (a, a'), end-plates (b), retaining bolts (c), and swivel pin (n) are of stainless steel, but the housing (d) of the electrical contacts is of low-density polipropilene. Electrical contacts inside the housing lead to two Mecca connectors (p) that mate with corresponding connectors on the cable.

Below is the mechanical swivel, made entirely of stainless steel; (a, a') are the lugs, (b) the swivel housing, (d) the greasing cap that serves as a pressure buffer, (e) the outside part of the swivel pin, and (f) the retaining screw for the housing plug.

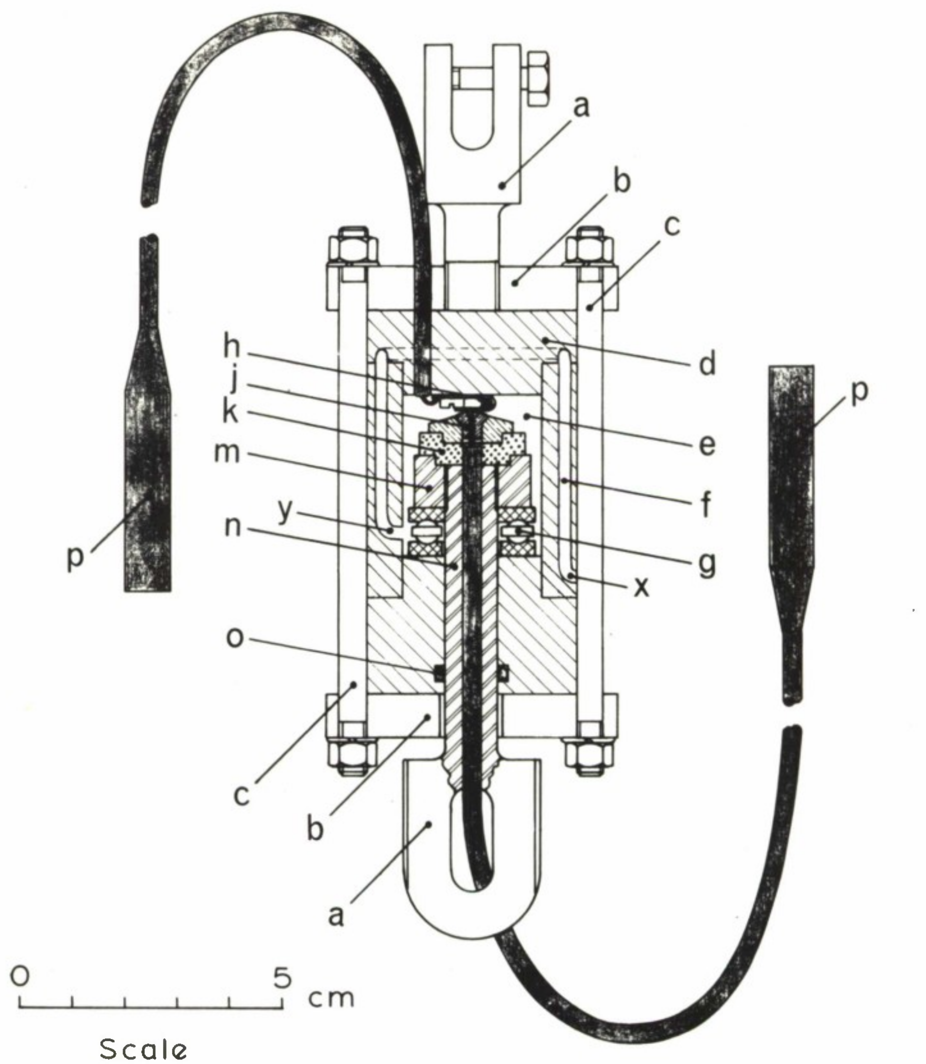


Fig. 2

Sectional drawing of the electrical swivel. The polipropilene housing (d) has stainless steel end-plates (b) held on by retaining bolts (c). The upper lug (a) is attached to the upper end-plate; the lower lug (a') to the swivel pin (n), which passes into the housing through an "O" ring (o). A stainless steel nut (m) is screwed onto the swivel pin and the whole revolves on pressure bearings (g).

An electrical conductor, passing tightly through the swivel pin core, terminates in a sharp-pointed brass head (j) insulated from the swivel pin and its nut by a Teflon spacer (k). The other conductor leads to a phosphor bronze spring contact against which the swivel pin head revolves. External electrical connections are through deep water Mecca connectors (p).

Petrolatum is packed inside both the chamber (e) and a buffer tube (f) leading from the chamber at y to the sea at x.

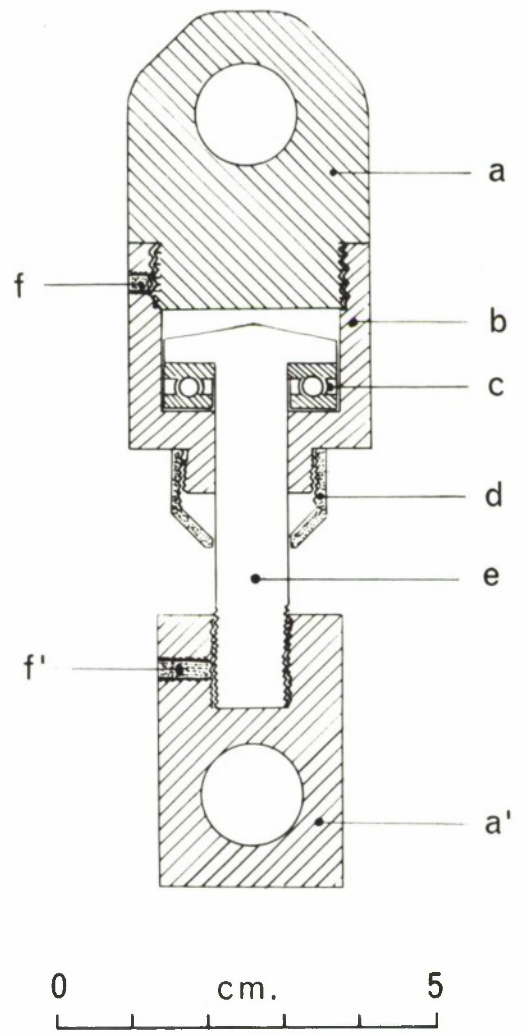


Fig. 3

Sectional drawing of the mechanical swivel. The upper lug (a) screws into the swivel housing (b), the lower lug (a') on to the end of the swivel pin (e); both are retained by grub screws (f, f'). The swivel pin head rests on pressure bearings (c) and is kept waterproof by petrolatum contained within the housing and, as a pressure buffer, in the hollow screw cap (d).

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