(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 845 636 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
03.06.1998 Bulletin 1998/23

(51) Int. Cl.[6]: **F23M 11/04**, F23N 5/08

(21) Application number: **97120145.4**

(22) Date of filing: **18.11.1997**

(84) Designated Contracting States:
AT BE CH DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **28.11.1996 DE 19649264**

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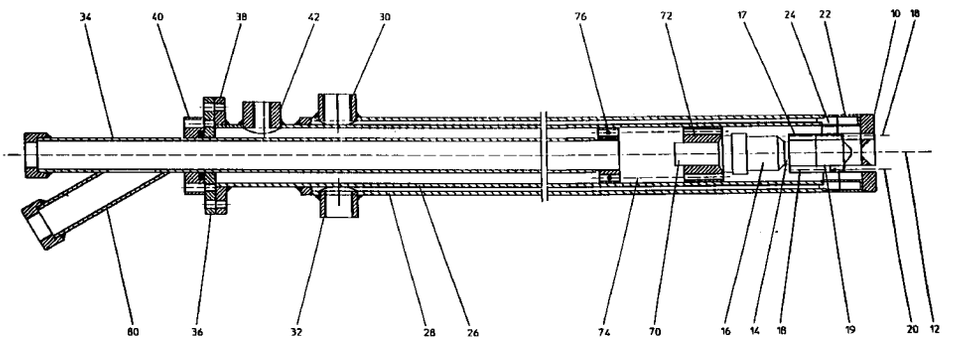
(54) A flame monitoring apparatus

(57) An apparatus for monitoring a flame is disclosed. It comprises a video camera (16) looking in flame direction and a plurality of light guide fibers observing the flame surroundings. These optical elements are mounted in a lance including a double-walled pipe (26,28) through which cooling water flows.



FIGUR 1

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Description

Field of the Invention

The present invention relates to an optical flame monitoring apparatus housed in a lance.

Background of the Invention

It is usual practice to monitor flames in industrial furnaces of e.g. a steam generator because, if a flame extinction occurs and is not recognized, the result could be desastrous because of continued fuel supply. Such flame monitors will produce a signal upon extinction of the flame so as to stop fuel supply.

Previous flame monitor designs of the prior art produced only signals representative of presence and absence of the flame. More recent designs attempt to collect as much information as possible concerning the combustion itself so as to be able to affect the combustion towards a desired optimum. Such optimum may be seen in maximum efficiency or minimum air pollution or even other parameters.

It is wellknown to monitor combustion by means of a video camera. A pixel sensor array in a video camera is read sequentially with the frame frequency, and therefore, the output signal for each pixel is the time integral over a frame period.

It would be desirable to obtain, in addition to the video information, supplemental optical information in real time primarily from the surroundings of the flame so as to process such supplemental information with regard to its spectrum and/or to fast temporal fluctuations.

Brief Description of the Invention

The present invention provides a flame monitoring apparatus capable to produce such supplemental information in real time. The apparatus comprises a lance adapted to be mounted on a furnace wall such that it is directed or aimed towards a flame. The lance houses a video camera and, in addition, light inlet ends of a plurality of light guide fibers. Light from the fibers may then be processed e.g. by means of a spectrum analyzer.

Brief Description of the Drawings

A preferred embodiment of the invention is illustrated in the drawings wherein

Fig. 1 is an axial section view of the lance,

Fig. 2 is a partially sectioned isometric explosion view of an end of the lance,

Fig. 3 illustrates support means of the optical parts in a manner similar to Fig. 2, and

Fig. 4 illustrates a partially sectioned plan view of a light fiber carrier.

Detailed Description of the Drawings

The lance illustrated in Fig. 1 comprises adjacent its end facing the flame a circular cover plate or protective disk 10 which is designed as a part subject to wear. It may easily be separated from the remainder of the lance and replaced with a fresh one. Disk 10 has three light inlet openings: A central circular aperture 12 axially aligned with a tubus 14 of a video camera 16 plus two slots 18, 20. These slots extend from the circumference of the disk inwards, are parallel to one another and offset relative to aperture 12. Disk 10 is shown as circumferentially welded to a heat sink member 22. However, other fastening means could be provided so as to simplify its replacement.

Heat sink member 22 is welded to an intermediate flange 24 which in turn is welded to a twin-walled heat sink tube comprising an inner tube 26 and an outer tube 28. The heat sink tube is supplied via a first fitting 30 with cooling liquid, preferably cooling water, drained via a second fitting 32.

Within the inner tube 26 there is a support tube 34 through which the power and signal lines (not shown) of camera 16 extend. Further, support tube 34 houses the light guide fibers which are glass fibers.

The other end of the support tube opposite to the flame is held by means of a flange 36 screw-connected to an end flange 38 of the heat sink tube and to a lid plate 40. The inner tube 26 extends beyond the end of the outer tube 28 and is provided with a fitting 42 permitting to inject pressurized air into the annular space between the inner tube 26 and the support tube 34. The air stream cleans the light transparent openings in disk 10 and contributes to cooling.

Referring now to Fig. 2, the design adjacent the flame facing end of the lance will be explained in more detail.

The annular heat sink member 22 has two diametrically opposite notches 44, 46 aligned with the slots of disk 10, i.e. each slot and an associated notch have a common central plane. On its side facing away from disk 10 the heat sink member has two recesses 48 each extending from one notch defining wall 50 to that wall which defines the other notch.

The heat sink member is welded to the intermediate flange 24. The latter forms a crown having two pairs of openings 52, 54 which when flange 24 is connected to the heat sink member 22 open into the recesses 48 laterally with respect to one of the notches 44, 46. The intermediate flange is welded with its side opposite the heat sink member to inner tube 26 and outer tube 28. The annular space between inner tube and outer tube is divided by two separating walls 56 extending parallel to the axis so as to form two halves one of which communicating with the inflow fitting 30 while the other communicates with the drain fitting 32. Inflowing cooling water flows through one of the halves of the annular space to the intermediate flange and through openings 52 into

the recesses 48 and from there through the associated opening 54 into the other half of the annular space. No sealing is provided between intermediate flange 24 and the end edges of separating walls 56 as a small leakage at this site is tolerable.

As may be seen in Fig. 1 a light guide holder 60 is fastened, preferably clamped on the tubus 14 of video camera 16; in Fig. 2 holder 60 is shown axially offset for sake of clarity. Holder 60 comprises clamp body 62 and two light guide carriers 62, 64 mounted thereon e.g. by means of screws. Each light guide carrier is L-shaped and provided with throughbores 68 each receiving a light guide, for example a glass fiber which is held preferably by clamp means, not shown. The light inlet ends of the light guides are disposed such that their axes extend in the central plane of notches 44, 46 and the axes are directed such that the light guides cover a large angle of preferably 90° but at least 75°. If each light guide has an aperture angle of, say, 20° five ore four light guides, respectively, will be necessary. Fig. 4 illustrates such a light guide carrier in partial section view.

Fig. 3 shows the video camera 16 and its tubus 14 and socket 70, the latter being held in a camera mount 72. The latter is tripod shaped, the legs thereof being in heat-conducting abutment on the inner tube 26 of the heat sink tube. The light guides extend through the interstices between the legs. Each leg of the mount is connected, by means of a bolt 74, to support tripod 76 which has in its center a through-hole provided with nut screw threads 78 for connecting it to the end of the support tube. The support tripod 76, too, is in heat conducting abutment with inner tube 26 of the heat sink tube. The light guides extend from their carriers into the support tube. At its end facing away from the flame the support tube has a branch 80 through which the light guides extend e.g. to spectroscopes while the camera cable extends through the support tube itself.

Claims

1. An apparatus for optically monitoring a flame, comprising:

   - a lance having a first end and a second end, said first end being adapted to be mounted on a furnace wall,
   - a support module disposed in said lance adjacent said first lance end,
   - a video camera supported by said module and directed towards a flame in a furnace,
   - light guide fibers having light inlet ends, said light inlet ends being mounted in said module and directed towards flame surroundings.

2. The apparatus of claim 1, further comprising a support tube, said module being fixed to said support tube, a video camera cable extending through said support tube, and said light guide fibers extending through said support tube.

3. The apparatus of claim 1, further comprising a heat sink member housing said module.

4. The apparatus of claim 3, further comprising a twin-walled heat sink tube, said heat sink member being disposed adjacent an end of said heat sink tube, and cooling liquid flowing through said heat sink tube.

5. The apparatus of claim 4, further comprising at least two separating walls extending between an inner wall and an outer wall of said heat sink tube thereby defining an inflow string and a drain string.

6. The apparatus of claim 5 wherein said heat sink member has at least one recess, each recess connecting an inflow string to a drain string.

7. The apparatus of claim 3, further comprising a protective disk mounted on said heat sink member.

8. The apparatus of claim 3 wherein said heat sink member has notches through which light may impinge on said light inlet ends.

9. The apparatus of 8, further comprising a protective disk mounted on said heat sink member and having slots aligned with said heat sink member notches.

10. The apparatus of claim 1 wherein said video camera has a tubus and said module comprises:

    - a video camera mount,
    - a support block mounted on said video camera tubus,
    - at least one light guide fiber carrier fixed to said support block and having bores receiving individual light guide fibers.

11. The apparatus of claim 10 wherein said bores are disposed in a common plane but angularly offset to one another.

12. The apparatus of claim 11, further comprising a heat sink member surrounding said module and having notches, a protective disk mounted on said heat sink member and having slots aligned with said notches, and said bores having axes extending in a common central plane of said slots and notches.

13. The apparatus of claim 10 wherein said video camera mount defines openings, and said light guide fibers extending through said openings.

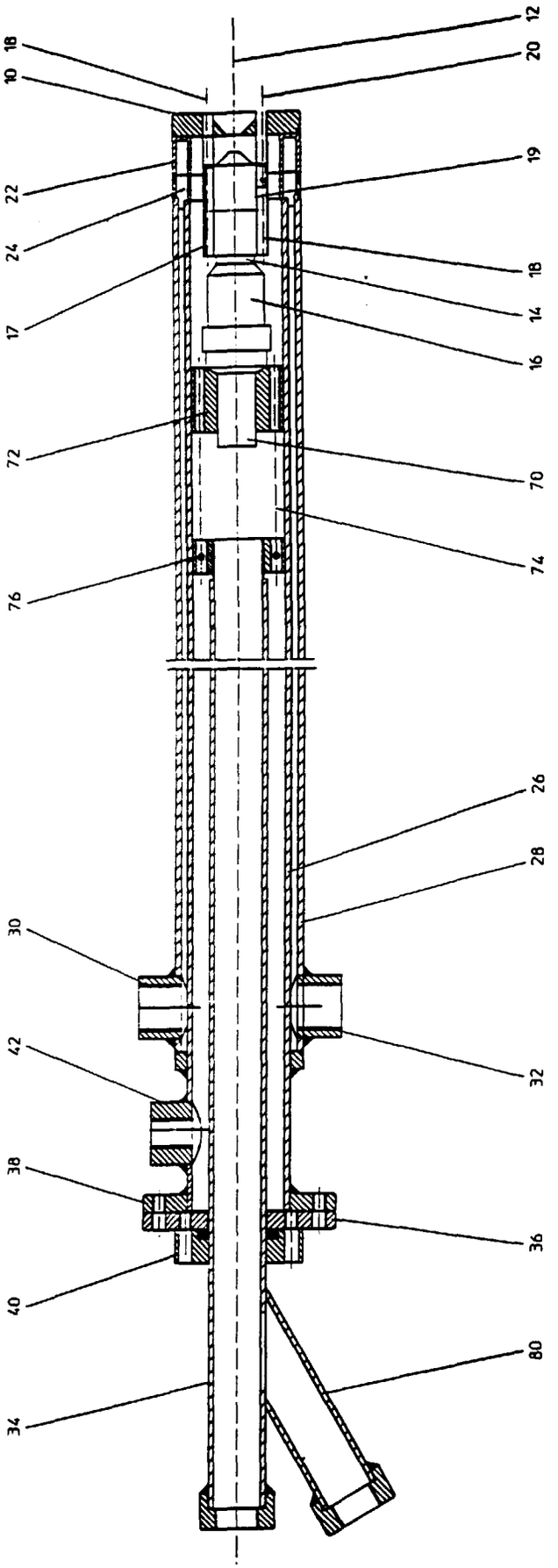
14. The apparatus of claim 13 wherein said video camera mount is tripod shaped.

15. The apparatus of claim 13, further comprising a support tube, a tripod member screwed to said support tube, and bolts connecting said video camera mount to said tripod member.

16. The apparatus of claim 15 wherein said support tube is centered within a heat sink tube by means of said tripod member.

17. The apparatus of claim 16 wherein said support tube and said heat sink tube define an annular space adapted to be supplied with pressurized air.

18. The apparatus of claim 11 comprising two fiber carriers, the bores of said fiber carriers commonly defining a sight angle of at least 150°, preferably 165°, and more preferably 180°.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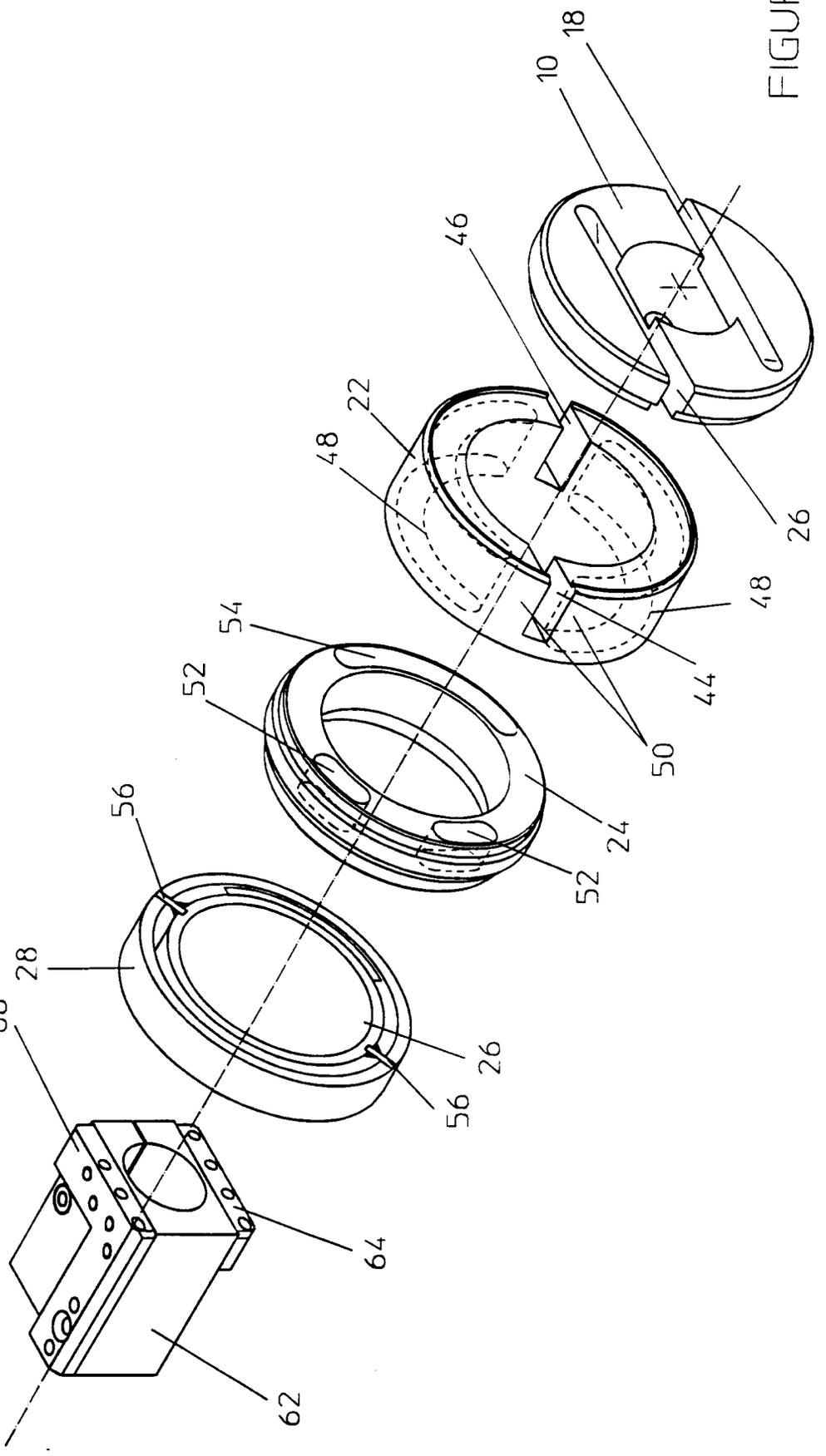
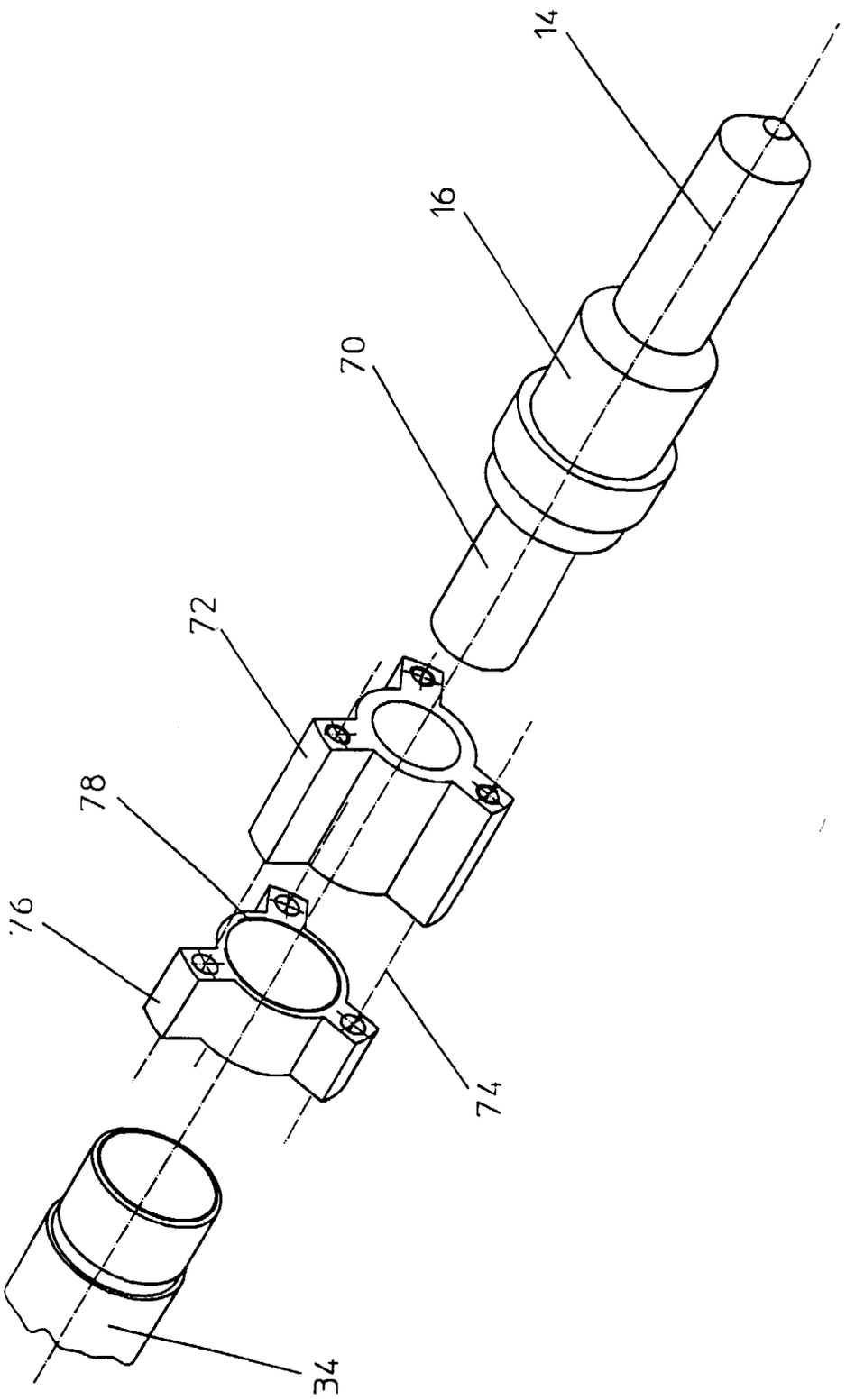
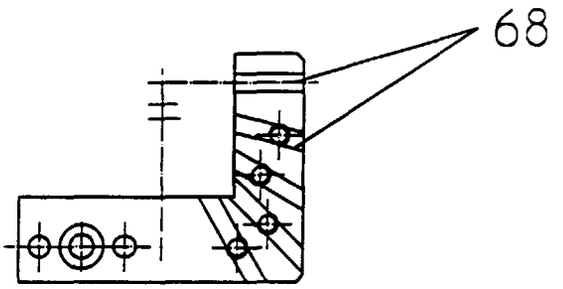
FIGUR 1



FIGUR 2



FIGUR 3



FIGUR 4