Feb. 21, 1967

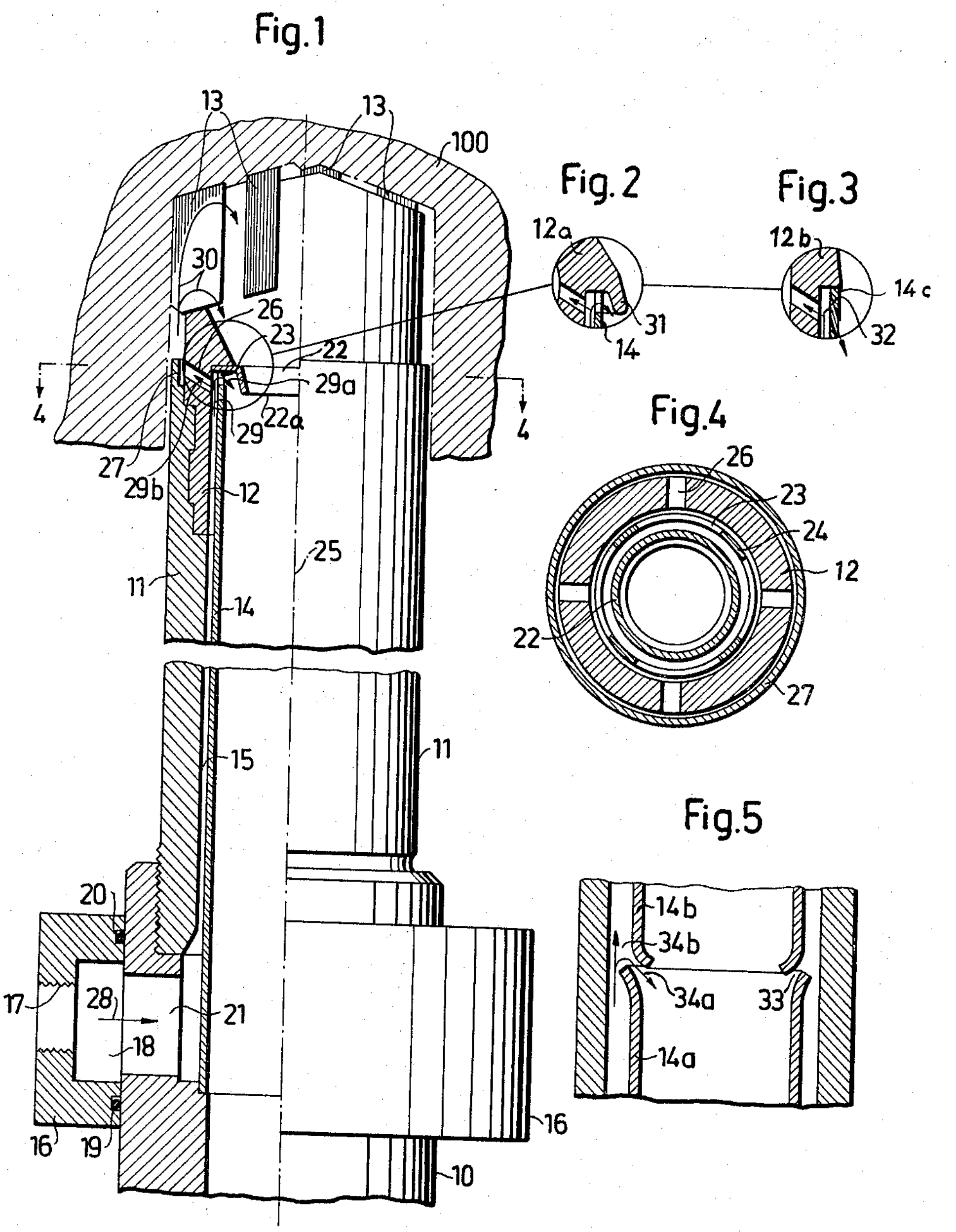
K. H. A. E. FABER

DRILL

3,304,815

Filed Dec. 11, 1964

4 Sheets-Sheet 1



Feb. 21, 1967 K. H. A. E. FABER 3,304,815

DRILL

Filed Dec. 11, 1964 4 Sheets-Sheet 2

Fig.6

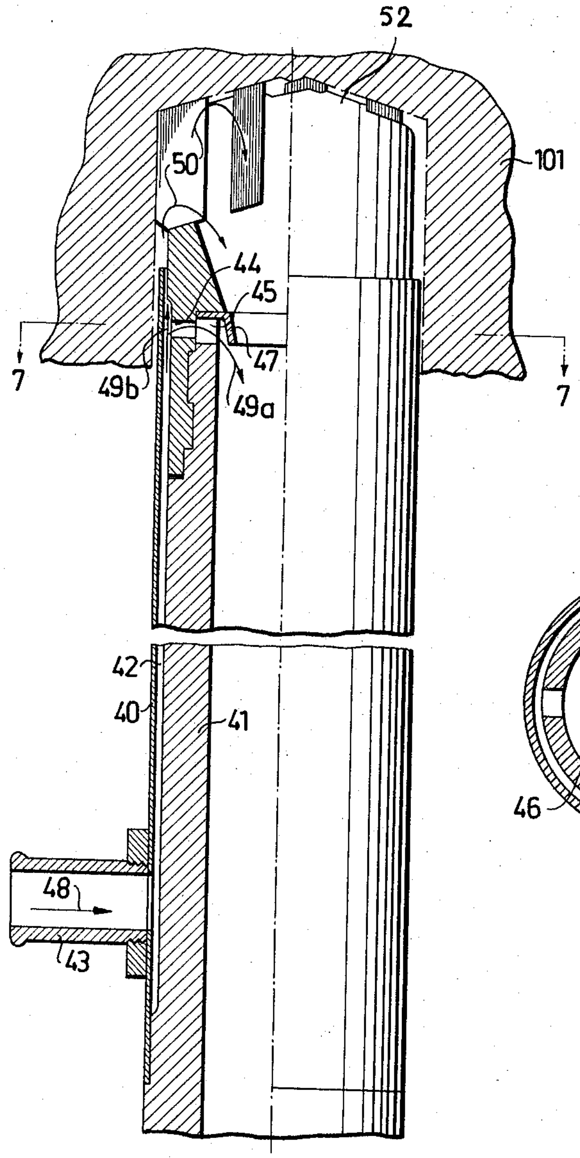
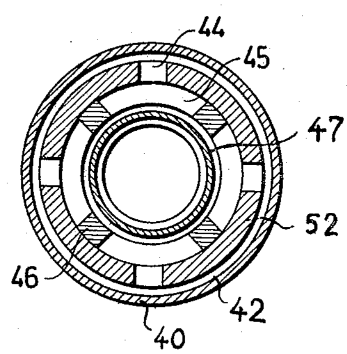


Fig.7



Feb. 21, 1967 K. H. A. E. FABER 3,304,815

DRILL

Filed Dec. 11, 1964 4 Sheets-Sheet 3

Fig.8

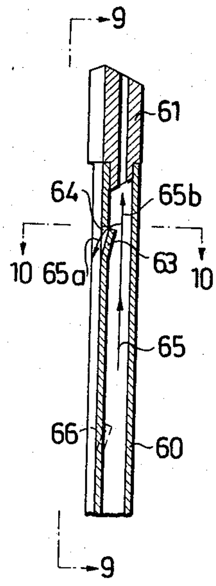


Fig.9

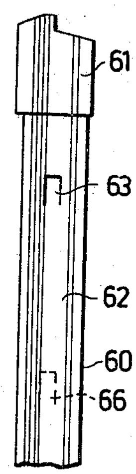


Fig.10

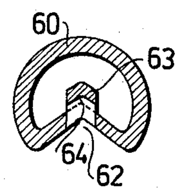


Fig.11

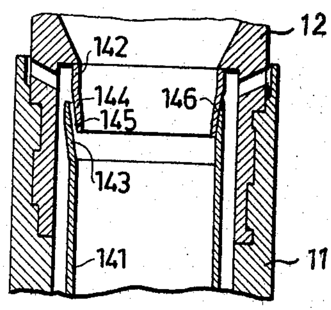
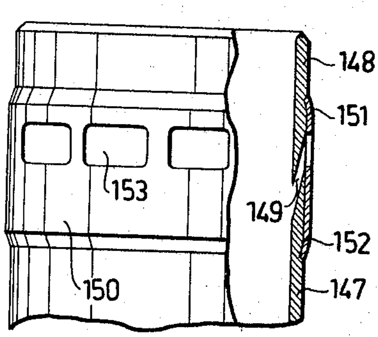


Fig.12



United States Patent Office

3,304,815

Patented Feb. 21, 1967

3,304,815

DRILL

Kurt Heinrich Albert Erich Faber, Sandviken, Sweden, assignor to Sandvikens Jernverks Aktiebolag, Sandviken, Sweden, a corporation of Sweden

Filed Dec. 11, 1964, Ser. No. 417,538
Claims priority, application Sweden, Dec. 14, 1963, 13,940/63
8 Claims. (Cl. 77—68)

The present invention relates to a drill having means for supplying a flushing medium to the front of the drill. The purpose of such flushing medium is to cool and lubricate the drill and also to remove the cuttings. The invention has been found especially useful in metal drills with a tubular drill stem, the chips formed during the drilling being removed through said stem.

In previously known drills the flushing medium has been supplied through openings or nozzles in the forward direction of the drill. Said medium has been returned by the contact with the bottom of the drill hole, the only force for bringing the medium rearwardly being the reaction force from the bottom of the hole when the forward flow reaches said bottom. This causes a pressure at the bottom of the hole and a tendency for leakage of flushing medium between the drill and the wall of the drill hole. Another disadvantage is that the rearward flow often is too weak to secure the desirable efficiency in removing the cuttings, i.e. chips in the case of metal drills.

A purpose of the present invention is to provide a separate rearward action on the return flow of the flushing medium thereby lessening the pressure of said medium at the front of the drill and also lessening the tendency of leakage. In this way it becomes unnecessary to use special gaskets for preventing the leakage. Said separate rearward action also improves the removal of cuttings.

The separate rearward action according to the invention is obtained by diverting a part of the flow of flushing medium before it reaches the front of the drill and guiding the diverted part rearwardly by means of nozzles or the like, thereby obtaining a rearward ejector effect. The rest of the flow, which continues to the front of the drill, is, on its return, mixed with the said diverted part and flows rearwardly therewith, the momentum of the diverted flow being imparted to the mixture, so that the whole flow has a homogenous rearward momentum. When the force for obtaining the rearward momentum is provided in this way by separate means it is obvious that the pressure of the flushing medium at the front of the drill may be smaller, thus diminishing the tendency for leakage. The strength of the diverted flow of medium can be increased without increasing the said pressure at the front, thus providing the desired rearward force of the flow for obtaining sufficient removal of the cuttings.

In the present specification the word "forward" relates to the axial penetration direction of the drill, the word "rearward" relating to the opposite direction.

Details of the construction and of the purposes of the invention appear from the following specification and the accompanying drawings in which:

FIG. 1 is partly a longitudinal section and partly an elevation of a tubular drill with a double wall according to the invention,

FIG. 2 is a longitudinal section of a modification of the encircled part of the drill in FIG. 1,

FIG. 3 is a longitudinal section of another modification of the encircled part of the drill in FIG. 1,

FIG. 4 is a cross section on the line 4—4 in FIG. 1,

FIG. 5 is a fragmentary longitudinal section of another modification of the drill in FIG. 1,

FIG. 6 is partly a longitudinal section and partly an elevation of a second embodiment of the drill,

FIG. 7 is a cross section on the line 7—7 in FIG. 6,

FIG. 8 is a longitudinal section of a third embodiment of a drill according to the invention,

FIG. 9 is a side elevational view of the drill in FIG. 8,

FIG. 10 is an enlarged cross section on the line 10—10 in FIG. 8,

FIG. 11 is a fragmentary longitudinal section of a modified detail of the drill in FIG. 1,

FIG. 12 is a fragmentary longitudinal section of another modification of the same detail that is shown in FIG. 11.

In FIG. 1 is shown a drill acting on a work piece **100**. The drill stem comprises a sleeve **10** and a tube **11**, which at its fore end carries the drill bit **12** which advantageously may be of the type disclosed in my application Ser. No. 271,054, filed April 8, 1963, and now abandoned. The front end of the drill bit has a number of cutting inserts **13**. Concentric with the tube **11** there is an inner tube **14** having a thinner wall than the outer tube, and there is an annular space **15** between the tubes. The rear end of the inner tube **14** abuts tightly against the sleeve **10**. An annular outer sleeve **16** surrounding the sleeve **10** has a hole **17** for supplying flushing medium to the drill. The outer sleeve **16** has at its inside an annular recess **18** which on both sides is surrounded by packings **19** and **20**. The sleeve **10** has an opening **21** connecting the recess **18** with the rear part of the space **15**. The described device permits rotation of the drill within the sleeve **16**, at the same time as a flushing medium is continuously supplied through the hole **17** to the space **15** as indicated by the arrow **28**.

The fore part of the inner tube **14** abuts against the flat portion of a ring **22** of relatively thin sheet material, said ring having a rearwardly inclined flange **22*a*** extending rearwardly within the tube **14**. The foremost part of the wall of the tube **14** has openings **23** separated by forwardly protruding portions **24** of the wall. The portions **24** abut against the ring **22**, the openings **23** forming slits along the ring. There are bores **26** in the wall of the drill bit. These bores **26** are surrounded by a flange **27** protruding from the outer tube **11** coaxially with the drill axis **25**.

The flushing medium is supplied at the rear end of the space **15** as indicated by the arrow **28**. When the flow of medium reaches the fore end of the space **15** it is divided into two branches as indicated by the arrow **29** having two branches **29*a*** and **29*b***. A part of the flow indicated by arrow branch **29*a*** passes through the openings **23** and is deflected rearwardly by the flange **22*a*** on the ring **22**. The rest of the flow indicated by arrow branch **29*b*** flows through bores **26** and is directed by the flange **27** forwardly to the cutting inserts and cutting edges, as indicated by the arrows **30**. The flow along the arrows **30** returns rearwardly from the bottom of the drill hole inside the drill and joins the flow ejected rearwardly at the ring **22**. In this way the total rearward flow is improved by the ejection effect of the diverted flow along the arrow **29*a***. The rearward action of the diverted flow lessens the pressure of the flushing medium at the front of the drill and consequently lessens the tendency for leakage between the drill and the wall of the hole. Said rearward action also improves the chip removal along the inside of the drill.

The flushing medium flows along the inside of the drill to a rear part of the drill where it is passed to the outside for instance through a sleeve device (not shown) similar to the medium supply structure **16–20**. After separating the chips from the flushing medium, the medium can be recirculated through the drill.

The flushing medium serves for lubricating, cooling and chip removal. Dependent upon which of these purposes is predominant and possibly other factors determined by the quality of the work piece, different flushing media can be used. Sometimes a liquid is suitable, as for instance oil. It is also possible to use water containing an emulsion of some lubricant. If a liquid is used it is preferable that it fills the circulation system, the internal tube **14** thus being filled by the liquid. In some cases a gas is suitable as flushing medium. When for instance drilling cast iron the flushing medium can be air carrying a mist of lubricant.

FIGS. 2, 3, 11 and 12 show various embodiments of the device for obtaining the rearward ejection effect, FIGS. 11 and 12 being variations of FIG. 3. In FIG. 2 a rearward flange **31** integral with the drill bit **12***a* guides the medium flow as indicated by the arrows in the same way as the flange **22***a* of the ring **22** in FIG. 1. In FIG. 3 the rearward flow is obtained by aid of one or more rearwardly inclined holes or slits **32** in the tube **14***c*.

According to FIG. 11 which is a modification of FIG. 3 the internal tube corresponding to the tube **14** of FIG. 1 is divided into two parts marked **141** and **142**. The adjacent ends of the parts **141** and **142** are slightly conical along portions **143** and **144**, between which there is an annular slit **145**. At intervals the outer conical portion **143** is closer to the axis as shown in the right hand part of the figure, forming contact points **146** between the portions **143** and **144**. There should be at least three such contact points, and the portions **143** and **144** are suitably brazed or welded together at said contact points.

FIG. 12, which is another variation of FIG. 3, shows the fore end of the internal tube, here marked **147**, on a larger scale than in the previous figures. In front of the tube there is a short tubular ring **148** which has the same diameter as the tube **147**. The adjacent ends of the tube **147** and the ring **148** are chamfered and placed at a distance from each other to form a slit **149** which is inclined inwardly and rearwardly. In order to hold the tube **147** and the ring **148** in the desired position a sleeve **150** is mounted around them. This sleeve **150** has its end edges **151** and **152** somewhat countersunk in shallow annular recesses around the tube **147** and the ring **148** to form an abutment determining the distance between the tube and the ring and the consequent width of the slit **149**. In the sleeve **150** there are holes **153** for the passage of flushing medium. The sleeve is suitably brazed to the tube and the ring.

It is important that the sides of the slits shown in FIGS. 3, 11 and 12 somewhat overlap each other in the direction of the slit in order to obtain the proper guidance of the flow of the medium. The inclination of the slit in relation to the drill axis should preferably be within the range 5–45° C. In order to avoid turbulence of the flow the inclination can advantageously be 8–15°.

The openings should be distributed as evenly as possible around the circumference of the tube in order to have a homogeneous and even flow.

For improving the ejector effect, especially in long drills, one or more extra ejector devices may be provided along the drill. FIG. 5 illustrates how the inner tube corresponding to the tube **14** of FIG. 1 is divided into two parts **14***a* and **14***b*, the adjacent ends being beveled and placed with a rearwardly and inwardly directed slit **33** between them. The parts **14***a* and **14***b* can be joined by spot welding or brazing at spaced intervals around the periphery, leaving slits between the joined spots for the flow of flushing medium. Said flow is divided into two parts, one **34***a* passing from the slit **33** rearwardly into the tube, the other **34***b* continuing forwardly towards the fore part of the drill. The device in FIG. 5 can be modified in the way shown in FIG. 12.

The drill in FIG. 1 has a thick outer tube **11** which is advantageous for obtaining the greatest possible moment of inertia of the drill and smallest possible stress in the material. Sometimes it is advantageous to have a thick inner wall and thin outer wall as shown in FIG. 6. The thin outer tube **40** is placed around the thick inner tube **41** with a narrow space **42** between the tubes. Flushing medium is supplied to the space **42** through the connection **43**. In this case the connection **43** is firmly attached to the drill, which means that the drill does not rotate but the work-piece **101** rotates. It is of course possible as an alternative to use the rotatable connection **16–20** shown in FIG. 1 on the drill of FIG. 6 or the stationary connection shown in FIG. 6 on the drill shown in FIG. 1.

The outer tube **40** of FIG. 6 extends to the drill bit **52** and passes at its fore end a ring of radial holes **44** through the wall of the drill bit. These holes are connected to openings **45** through the fore end of the inner tube **41**. The openings **45** are separated by lugs **46** (FIG. 7) which are integral with the tube **41**. The lugs **46** abut against an annular ring **47** similar to the ring **22** of FIG. 1, having the internal edge rearwardly bent. The ring **47** rests against the drill bit **52**.

When the flow of flushing medium, supplied at the connection **43** and indicated by the arrow **48**, reaches the fore end of the space **42**, a part of the flow is diverted along the arrow **49***a*, the rest of the flow continuing forwardly along the arrow **49***b*. The diverted part of the flow goes through the holes **44, 45** and is deflected rearwardly by the ring **47**. The rest of the flow goes up to the bottom of the drill hole and returns as indicated by the arrows **50**, whereafter it joins the rearward flow from the ring **47**. In this way the same ejector effect is obtained as above described in connection with FIG. 1.

FIGS. 8–10 show a so-called gun drill comprising a tubular part **60** and a drill bit **61**. As appears from FIG. 10 the tubular part has a cross section which is partly inwardly deflected to a V-shaped groove **62**. The drill bit has a corresponding groove. The chips are removed along the groove **62**. In the bottom of the groove a lug shaped portion **63** is cut out in the wall of the tube and bent inwardly, thereby forming an opening **64** facing rearwardly. Flushing medium is supplied in the direction indicated by the arrow **65** and the flow is divided at the opening **64** into a rearwardly directed flow **65***a* through the wall of the V-shaped recess and a forwardly directed flow **65***b*, which passes through a bore in the drill bit **61** to the cutting edges. The ejector effect of the flow along the arrow **65***a* as well as the flow returning from the cutting edges carry the chips. There can be additional openings along the drill with ejector effect as indicated by broken lines at **66**.

The invention is illustrated in connection with a metal drill which represents an important field of use for the invention, but it can also be employed in connection with other kinds of drills as for instance tubular rock and earth drills.

I claim:

1. A drill for chip cutting drilling of a metal workpiece comprising a tubular shaft having an inner and an outer wall with a space therebetween, cutting edges on the front end of said shaft, at least one of said cutting edges extending laterally beyond the outer surface of said tubular shaft, means for delivering flushing medium to said space, a first aperture having its outlet at the outer surface of said outer wall rearwardly of said cutting edges for delivering a forwardly directed first flow of flushing medium from said space to said cutting edges, a passageway permitting return flow of flushing medium from said cutting edges to the cavity within said inner wall and a second aperture having its outlet at the inner surface of said inner wall for delivering a second flow in the form of a rearwardly directed jet of flushing medium from said space into said cavity.

2. Drill according to claim **1** in which the rearward direction of the second flow is obtained by means of a flange around the periphery of the inner wall adapted to deflect the flow from the second aperture rearwardly,

the second aperture comprising a number of openings spaced around the periphery of the inner wall.

3. Drill according to claim 1 in which the rearward direction of the second flow is obtained by means of a rearward direction of the second aperture.

4. Drill according to claim 3 in which the second aperture consists of a number of openings surrounding the inner cavity of the drill shaft.

5. Drill according to claim 3 in which the second aperture substantially has the shape of an annular slit around the periphery of the inner wall, said slit being subdivided and forming a number of arcuate slits.

6. Drill according to claim 1 in which the first aperture has the shape of a number of openings around the periphery of the outer wall of the drill shaft, a flange surrounding said openings for deflecting the flow forwardly on the outside of the drill.

7. Drill according to claim 1 in which the jet effect of the second flow is sufficiently strong to prevent leakage outwardly of the first flow between the outside of the drill and the wall of the drilled hole.

8. Drill according to claim 1 in which a third aperture is arranged in the inner wall to the rear of the second aperture for obtaining a third, rearwardly directed flow cooperating with and increasing the rearward jet effect of the second flow.

References Cited by the Examiner

UNITED STATES PATENTS

1,281,420 10/1918 Reid ---------------- 77—68

FRANCIS S. HUSAR, *Primary Examiner.*