

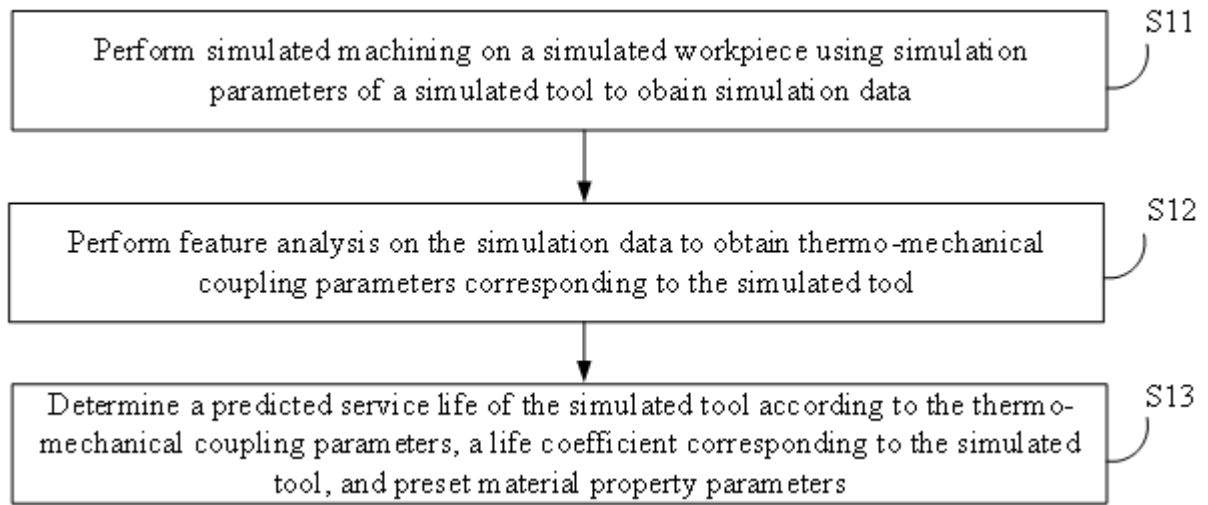


FIG. 1

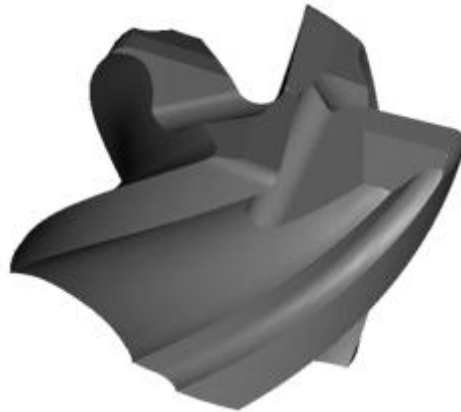


FIG. 2

| Material grade of the simulated tool | Axial rake angle | Axial relief angle |
|--------------------------------------|------------------|--------------------|
| L108                                 | 4°               | 14°                |
| K44UF                                | 8°               | 8°                 |
| CTS24Z                               | 12°              | 12°                |
| F6                                   | 15°              | 10°                |
| F6                                   | 6°               | 8.5°               |
| L108                                 | 6°               | 8.5°               |
| K44UF                                | 6°               | 8.5°               |
| CTS24Z                               | 6°               | 8.5°               |

FIG. 3

| Material grade of the simulated tool |                   | L108  | K44UF | CTS24Z | F6    |
|--------------------------------------|-------------------|-------|-------|--------|-------|
| Tool material property parameters    |                   |       |       |        |       |
| Density                              | kg/m <sup>3</sup> | 14450 | 14150 | 14150  | 14500 |
| Young's modulus                      | GPa               | 550   | 520   | 520    | 560   |
| Poisson's ratio                      |                   | 0.21  | 0.23  | 0.23   | 0.18  |
| Thermal conductivity                 | W/m/°C            | 55    | 53    | 53     | 58    |
| Specific heat capacity               | J/kg/°C           | 700   | 850   | 700    | 650   |

FIG. 4

| Material grade of the simulated tool |                   | CTS24Z |
|--------------------------------------|-------------------|--------|
| Tool material property parameters    |                   |        |
| Density                              | kg/m <sup>3</sup> | 14150  |
| Young's modulus                      | GPa               | 520    |
| Poisson's ratio                      |                   | 0.23   |
| Thermal conductivity                 | W/m/°C            | 53     |
| Specific heat capacity               | J/kg/°C           | 700    |
| Cobalt content                       | M %               | 12.0   |
| Hardness                             | HV30              | 1570   |
| Transverse rupture strength          | Mpa               | 4000   |

FIG. 5

| Machining parameters | Unit     | Value |
|----------------------|----------|-------|
| Rotational speed     | RPM      | 6000  |
| Feed per tooth       | mm/tooth | 0.075 |
| Cutting width        | mm       | 3.2   |
| Cutting depth        | mm       | 0.2   |

FIG. 6

| Machining parameters           | Unit          | Value |
|--------------------------------|---------------|-------|
| Rotational speed               | RPM           | 6000  |
| Total feed amount              | mm/min        | 1800  |
| Number of cutting flutes       | count         | 4     |
| Feed per tooth                 | mm/tooth      | 0.075 |
| Cutting width                  | mm            | 3.2   |
| Cutting depth                  | mm            | 0.2   |
| Cutting fluid<br>concentration | concentration | 12%   |

FIG. 7

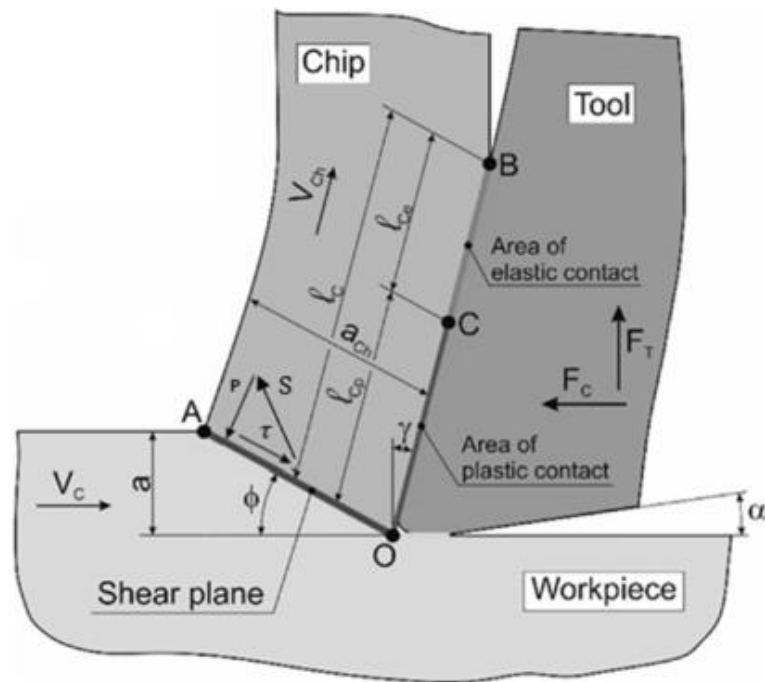


FIG. 8

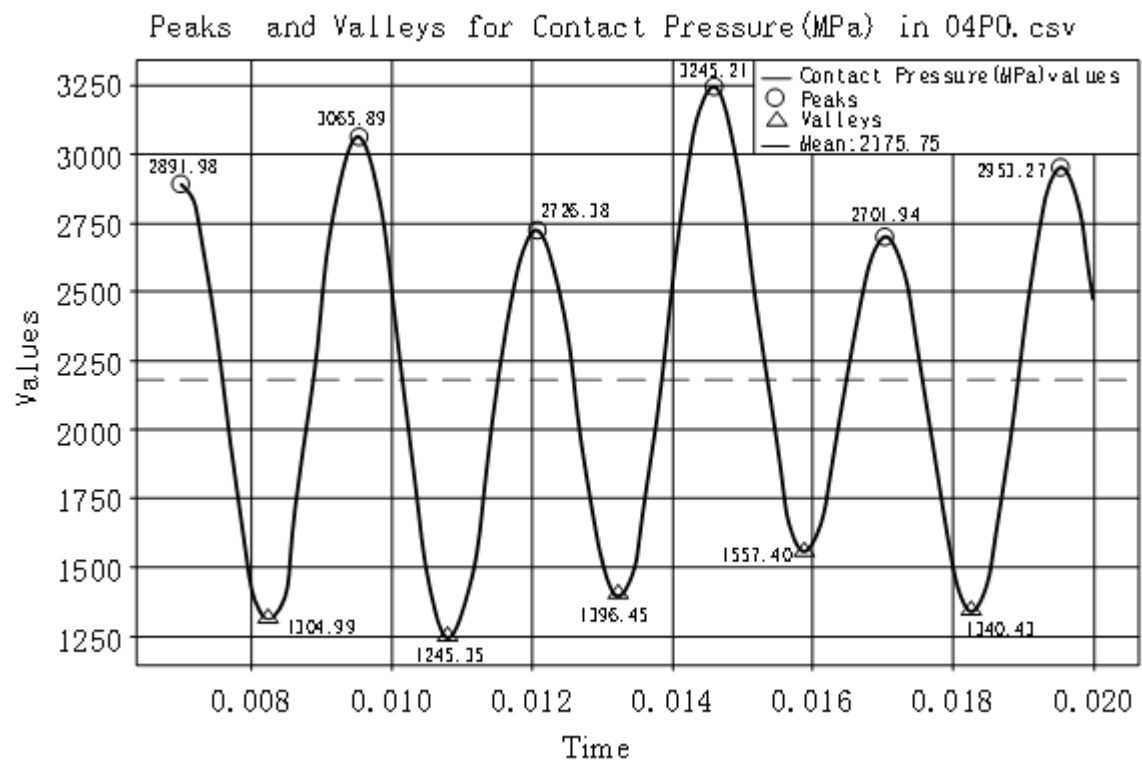


FIG. 9

| Simulation number | Axial rake angle | Axial relief angle | Material grade of the simulated tool | Target contact pressure (mpa) | Target shear stress (mpa) | First target temperature $t_p(^{\circ}\text{C})$ | Second target temperature $t_v(^{\circ}\text{C})$ |
|-------------------|------------------|--------------------|--------------------------------------|-------------------------------|---------------------------|--------------------------------------------------|---------------------------------------------------|
| 1                 | 4°               | 14°                | L108                                 | 2000.0                        | 991                       | 816.9                                            | 672.9                                             |
| 2                 | 8°               | 8°                 | K44UF                                | 2265.9                        | 777                       | 726.8                                            | 579.8                                             |
| 3                 | 12°              | 12°                | CTS24Z                               | 1907.3                        | 765                       | 807.7                                            | 667.7                                             |
| 4                 | 15°              | 10°                | F6                                   | 1510.7                        | 1015                      | 761.5                                            | 620.3                                             |
| 5                 | 6°               | 8.5°               | F6                                   | 1774.8                        | 618                       | 773.9                                            | 638.9                                             |
| 6                 | 6°               | 8.5°               | L108                                 | 1672.4                        | 624                       | 770.4                                            | 638.9                                             |
| 7                 | 6°               | 8.5°               | K44UF                                | 1731.2                        | 632                       | 773.8                                            | 629.8                                             |
| 8                 | 6°               | 8.5°               | CTS24Z                               | 1632.6                        | 531                       | 780.8                                            | 644.8                                             |

FIG. 10

| Material grade of simulated tool | Rotational velocity coefficient A | Stress coefficient B | Tool material first constant C | Thermal shock strength coefficient D | Tool material second constant E |
|----------------------------------|-----------------------------------|----------------------|--------------------------------|--------------------------------------|---------------------------------|
| L108                             | 506000                            | 1750                 | 0.09                           | 130                                  | 0.16                            |
| CTS24Z                           | 506000                            | 1700                 | 0.06                           | 135                                  | 0.13                            |
| K44UF                            | 506000                            | 1700                 | 0.06                           | 140                                  | 0.14                            |
| F6                               | 506000                            | 1750                 | 0.06                           | 130                                  | 0.13                            |

FIG. 11

| Scheme type | Axial rake angle | Axial relief angle | Axial relief angle of corner radius | Radial relief angle of corner radius | Radial rake angle | radial relief angle | Average cutting life (meter) |
|-------------|------------------|--------------------|-------------------------------------|--------------------------------------|-------------------|---------------------|------------------------------|
| A11         | 12               | 8                  | 8                                   | 14                                   | 5                 | 14                  | 40                           |
| A12         | 12               | 8                  | 5.5                                 | 14                                   | 8.5               | 14                  | 85                           |
| A13         | 12               | 8                  | 8                                   | 14                                   | 8.5               | 14                  | 80                           |
| A14         | 6                | 8.5                | 8.5                                 | 10                                   | 7                 | 10                  | 65                           |

FIG. 12

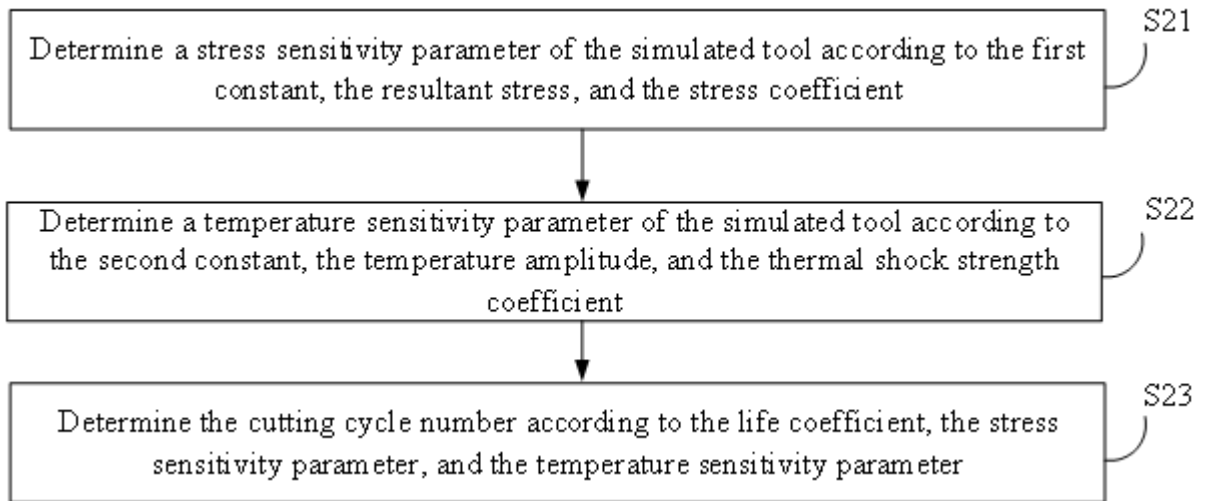


FIG. 13

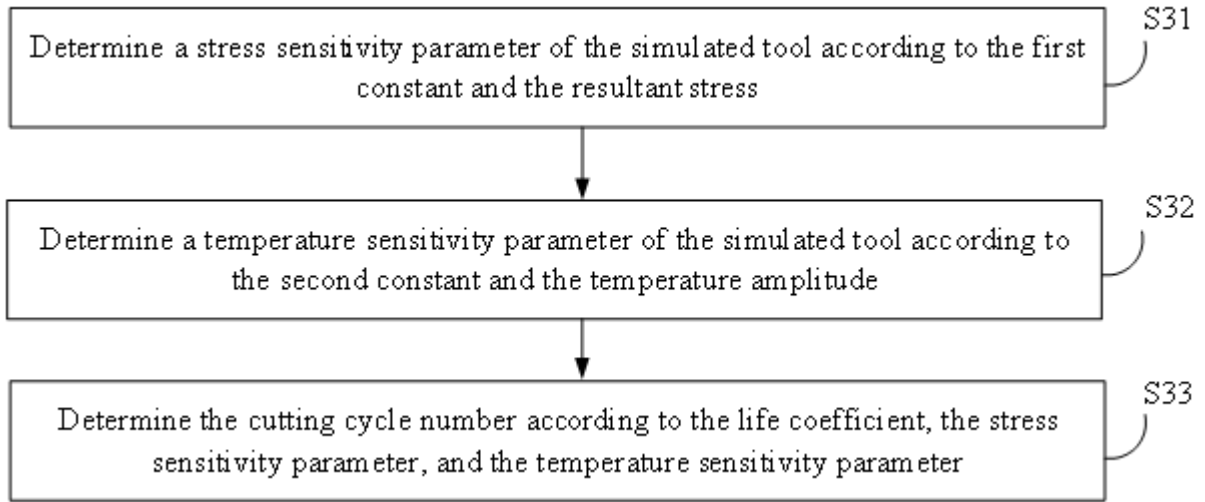


FIG. 14

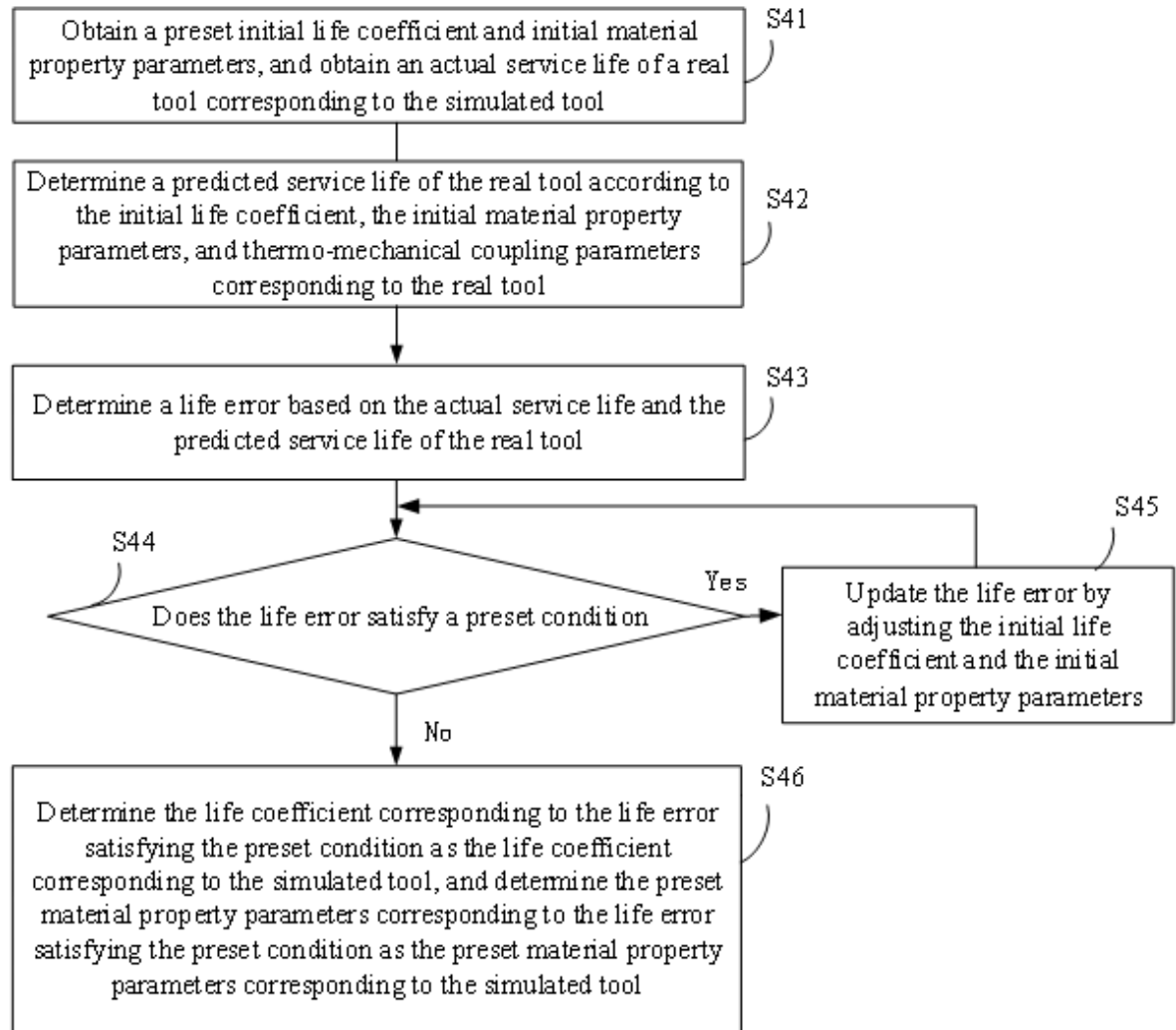


FIG. 15

| Axial rake angle | Axial relief angle | Material grade corresponding to the real tool | Actual cutting cycle number | Predicted cutting cycle number |
|------------------|--------------------|-----------------------------------------------|-----------------------------|--------------------------------|
| 4°               | 14°                | L108                                          | 193333                      | 190234                         |
| 8°               | 8°                 | K44UF                                         | 260000                      | 256281                         |
| 12°              | 12°                | CTS24Z                                        | 326667                      | 310465                         |
| 15°              | 10°                | F6                                            | 306667                      | 286448                         |
| 6°               | 8.5°               | F6                                            | 306944                      | 306612                         |
| 6°               | 8.5°               | L108                                          | 361111                      | 344358                         |
| 6°               | 8.5°               | K44UF                                         | 325000                      | 293592                         |
| 6°               | 8.5°               | CTS24Z                                        | 505556                      | 493553                         |

FIG. 16

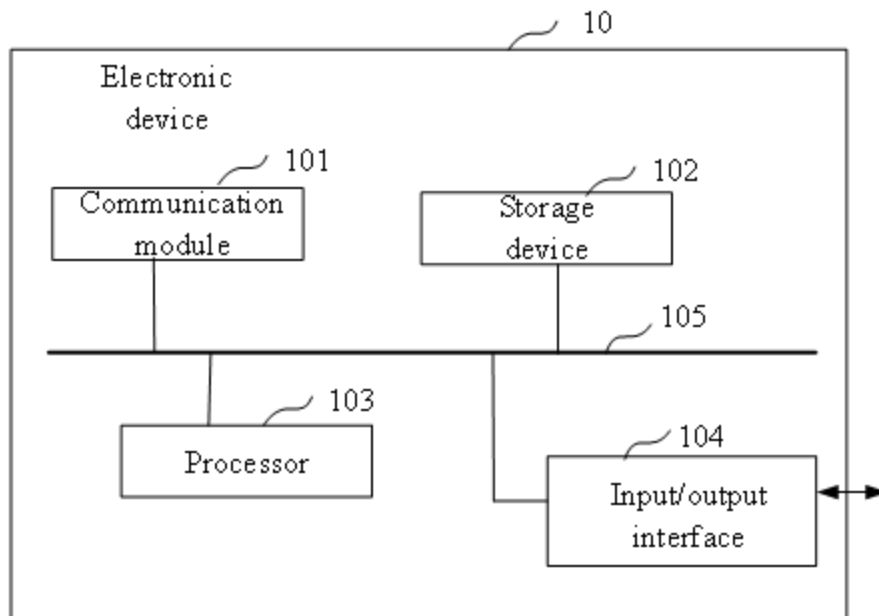


FIG. 17