In recent years, chromium carbide-base alloys cemented with nickel have been added to the available industrial tool materials, previously represented mainly by the VK and TK hard alloys* [1, 2]. These alloys possess a combination of properties which enables them to operate satisfactorily in service where good resistance to abrasive wear, corrosive media, and elevated temperatures is required. Depending on their size, parts in chromium carbide alloys are produced by sintering compacts at 1250-1350°C or by hot pressing at 1180-1290°C.

The lower the hot-pressing temperature of an alloy, the simpler is the process of producing parts in it and the less power has to be expended during pressing. Now it has already been established that the sintering temperature of chromium carbide-nickel alloys can be lowered by alloying their nickel binder with phosphorus [3]. In this connection, the present work was undertaken with the aim of investigating the effects of phosphorus additions (of up to 4 wt.%) to the nickel binder upon the hot-pressing temperature, density, hardness, and transverse rupture strength of chromium carbide alloys with 5, 10, 15, 20, and 30% of binder phase (henceforth referred to as KKhNF-5, KKhNF-10, etc.).

A nickel-phosphorus alloy was prepared by depositing diammonium phosphate from its aqueous solution onto a nickel powder, evaporating off the solution with continuous mixing of the powder, and subjecting the resultant mixture to reduction annealing for 2 h at 700°C in hydrogen. A chemical analysis revealed that the nickel-phosphorus alloy powder contained 3.5 wt.% phosphorus. The nickel-phosphorus alloy powder produced in this way was employed as cementing metal in the manufacture of chromium carbide alloys.

Mixtures consisting of a chromium carbide (Cr3C2) powder and the nickel-phosphorus alloy powder were produced by the standard process used in the manufacture of chromium carbide-nickel alloy powder mixtures. The duration of the milling and mixing operation was 50 h. The mixtures were then subjected to drying and screening, after which tests were carried out to determine the processing parameters of the hot-pressing process. Most of these tests were conducted on 50-mm diameter x 6-mm high specimens.

Hot pressing was performed in a graphite die at temperatures varying, in 20°C intervals, from 940 to 1090°C, a pressure of 50 kg/cm², and a holding time of 5 min. Heating was effected with the aid of a furnace mounted on the press, within which was placed the die with powder. The results of tests in which the effects were studied of hot-pressing temperature upon the room-temperature density and hardness of hard alloy specimens are shown in Figs. 1 and 2.

The maximum density in alloys containing 5-15% of the binder metal is observed at hot-pressing temperatures of 1040-1070°C. The density of alloys with (Ni-P) contents of 20-30% attains its maximum at pressing temperatures of 980-1020°C. Alloys with 5-15% of (Ni-P) exhibit the highest hardness after pressing at a temperature of 1040°C, and those with 20-30% (Ni-P) after pressing at 980°C (Fig. 2).

*WC+Co and WC+TiC+Co alloys, respectively - Translator.

An investigation into the hot-pressing temperature dependence of the transverse rupture strength of chromium carbide-base hard alloys containing 5, 10, and 15% of the nickel-phosphorus binder and subjected to the action of a concentrated load was carried out using 5-mm square x 35-mm long specimens cut with a diamond disk from cylindrical alloy blanks. A special device, mounted on a UMM-5 testing machine, was employed for this purpose. The distance between the supports was 30 mm. The results of these tests are illustrated in Fig. 3.

From an examination of the experimental data, it can be seen that the highest level of strength is attained at hot-pressing temperatures of 1040-1070°C for KKhNF-5 and KKhNF-10 alloys, and at 1020-1040°C for an alloy with 15% (Ni-P). It will be noted that the strength of KKhNF-10 and KKhNF-15 alloys varies only slightly over the temperature range 1040-1070°C, while the maximum values of density and hardness for these alloys are observed at 1040°C. On the basis of these results, it may be concluded that the hot-pressing of chromium carbide alloys with 10 and 15% (Ni-P) should be performed at 1040°C. Chromium carbide containing 5% (Ni-P) exhibits the highest values of density, hardness, and transverse rupture strength at hot-pressing temperatures of 1040-1070°C. It is interesting to note that the level of strength